

COLECOVISION CODING GUIDE

WITH THE ABSOLUTE COLECO BIOS LISTING

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## ACKNOWLEDGEMENTS

*From ADAM™ Technical Reference Manual*

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## **PREFACE**

This document is a source of technical information for software designers. This preliminary release includes the most essential information.

Section I, BEFORE PROGRAMMING, shows an overview of all the necessary informations to know before programming a real ColecoVision game.

Section II, OS 7' ROUTINES SPECIFICATIONS, covers all the functions of the ColecoVision BIOS with necessary information to properly use them.

Section III, OS 7' ABSOLUTE LISTING, supplies listing for the ColecoVision BIOS code.

Section IV, APPENDIX, contains suplement of information about the ColecoVision itself.

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## **BEFORE PROGRAMMING**

Source : ColecoVision Programmers' Manual

The following text shows what to know before programming a real ColecoVision game.

### ***Defined Reference Locations***

In the OS ROM area, it's IMPORTANT to know that the application programs (games) should only use the OS entry points and global symbols listed in the appendix. Accessing to the OS otherwise is illegal and may cause program malfunction when hardware configuration changes or OS routines relocated due to update. This warning still important today to keep the compatibility of the games with the actual and future ColecoVision clones.

### ***Europe/America Byte***

The European TV uses PAL system (625-line format) which requires interrupt at the end of each active-display scan every 1/50 second, as opposed to every 1/60 second for the American model (NTSC, 525-line format). ColecoVision cartridges must be interchangeable between both systems. If a real-time display (such as a clock) must be implemented, the program will have to access the Europe/America byte (0069h) to determine the current line frequency: 60 (3Ch) for America-based units, and 50 (32h) for European-based units.

### ***Graphics Tables***

There are two(2) graphics tables in the OS available to the user. The pointers to these tables are defined in the locations ASCII\_TABLE (006Ah) and NUMBER\_TABLE (006Ch). It's IMPORTANT to get the pointers to the ASCII and number generator tables by using these locations.

The ASCII table contains pattern generators for all 26 upper and pseudo-lower (half-size upper) case letters plus eleven special characters in 5x7 dot matrix form. The number table contains pattern generators for the numbers from 0 to 9 plus seven special characters.

### ***Cartridge ROM***

At the beginning of the Cartridge ROM, locations are reserved for testing cartridge presence (8000h; AAh 55h to display OS logo screen, 55h AAh to not display OS logo screen), plus a number of pointers which points to tables, buffers and start of the game (see the Appendix for details). After the pointers, it's the programmable restart and interrupt vectors. And after the vectors, at GAME\_NAME location (8024h) it's normally the space (up to 60 bytes) reserved to show game informations on the logo screen.

Of course, we know now that the space for the game informations on the logo screen could be bigger than 60 bytes, however, this size of 60 bytes is really enough.

## **RAM Areas**

Eleven(11) bytes are reserved for OS sound data starting at 7020h; seventy-one(71) bytes at the high end of memory are used by various OS routines. The top of the stack is sitting at address 73B9h which grows in the decrementing direction. Between stack and user buffer there are 942 bytes available for the application program. However, care should be exercised in both size and boundary when using RAM as scratch pad.

Special note: the stack pointer address is set by the OS before running the game, and it's a good practice to never set yourself the stack pointer specially if the game uses the OS functions.

Of course, if the game don't use the OS sound routines, the reserved locations 7020h-702Ah can be used for any purpose.

## **Dealing with OS Bugs**

### **WRITE\_VRAM AND READ\_VRAM**

It works as advertised for byte counts less than 256 (00h-FFh) and for byte counts that are multiples of 256 (100h, 200h,...). For other values, it subtracts 256 (100h) from the actual byte count. Programmers should deal with this problem by always sending numbers of bytes that are less than or even multiples of 256 (100h). They should not deal with it by padding their byte counts as this may lead to cartridges that fail when the bug is fixed. Note : PUT\_VRAM and GET\_VRAM call these routines, so take care.

### **SEMI-MOBILE OBJECT IN GRAPHIC MODE 1**

In the graphic mode 1, ACTIVATE writes the pattern generators for a semi-mobile object to VRAM properly, but miscalculates the number and placement in VRAM of the corresponding color bytes when operating on generators in the upper half of the stable. Programmers should avoid using ACTIVATE to write pattern generators to VRAM in graphic mode 1, - OR - , first of all, count on having to write the color table separately, and second, count on guarding against VRAM corruption by isolating the color table.

### **PUT\_MOBILE PATCH**

Due to an error near the beginning of the PUT\_MOBILE routine, the beginning part of PUT\_MOBILE will have to be included as part of the cartridge program. Calling the fixed version inside the cartridge instead of the version in the OS has two side effects: mobile objects may not be components of a complex object, the deferred write condition will not be recognized by PUTMOBILE.

The following code is the section of PUT\_MOBILE to be part of the cartridge program.

Remark : the red color is used here to show the difference between two(2) versions of PUTMOBILE, one for graphic mode 1 and a second for graphic mode 2.

|             |     |       |
|-------------|-----|-------|
| WORK_BUFFER | EQU | 8006h |
| FLAGS       | EQU | 3     |
| FRM         | EQU | 4     |
| YDISP       | EQU | 0     |
| XDISP       | EQU | 1     |
| YP_BK       | EQU | 18    |
| XP_BK       | EQU | 17    |

```

PX_TO_PTRN_POS      EQU    07E8h
GET_BKGRND          EQU    0898h
PM2                  EQU    0AE0h

;
; PUTMOBILE version GRAPHICS MODE I
;
PUTMOBILE:           LD  IY,[WORK_BUFFER]
                     RES  7,B
                     LD  [IY+FLAGS],B
                     PUSH HL
                     LD  H,[IX+3]
                     LD  L,[IX+2]
                     LD  A,[HL]
                     LD  [IY+FRM],A
                     XOR  80h
                     LD  [HL],A
                     INC  HL
                     LD  E,[HL]
                     LD  A,E
                     AND  7
                     NEG
                     ADD  A, 8
                     LD  [IY+XDISP],A
                     INC  HL
                     LD  D,[HL]
                     CALL PX_TO_PTRN_POS
                     LD  [IY+XP_BK],E
                     INC  HL
                     LD  E,[HL]
                     LD  A,E
                     AND  7
                     LD  [IY+YDISP],A
                     INC  HL
                     LD  D,[HL]
                     CALL PX_TO_PTRN_POS
                     LD  [IY+YP_BK],E
                     LD  HL,[WORK_BUFFER]
                     LD  DE,YP_BK+1
                     ADD  HL,DE
                     LD  D,[IY+YP_BK]
                     LD  E,[IY+XP_BK]
                     LD  BC,303h
                     PUSH IX
                     CALL GET_BKGRND
                     POP  IX
                     PUSH IX          ; Save another copy of object pointer
                     CALL PM2         ; Call rest of OS PUT_MOBILE routine
                     POP  IX          ; Restore object pointer
                     LD  IY,3         ; Set up for 3 item VRAM write
                     LD  A,[IX+6]     ; Get FIRST_GEN_NAME
                     LD  B,A          ; And save another copy
                     AND  A,7         ; Evaluate MOD 8
                     CP  7           ; If not equal 7 then
                     JR  NZ,THREE_GEN ; 3 generators to move
                     LD  IY,4         ; Else, move 4 generators
THREE_GEN:           LD  A,B          ; A := FIRST_GEN_NAME
                     SRL  A           ; Divide by 8
                     SRL  A
                     SRL  A
                     LD  E,A          ; DE gets pointer to object's
                     LD  D,0          ; color gens in VRAM

```

```

        LD HL,WORK_BUFFER+88h ; Point to 4th gen
        PUSH HL                ; Save pointer
        LD A,[HL]
        LD B,3                  ; Copy this generator 3 times
COPY3:   INC HL
        LD [HL],A
        DJNZ COPY3
        POP HL                  ; Get back pointer
        LD A,4                  ; Code for color table
        JP PUT_VRAM

;
; PUTMOBILE version GRAPHICS MODE II
;
PUTMOBILE: LD IY,[WORK_BUFFER]
           SET 7,B
           LD [IY+FLAGS],B
           PUSH HL
           LD H,[IX+3]
           LD L,[IX+2]
           LD A,[HL]
           LD [IY+FRM],A
           XOR 80h
           LD [HL],A
           INC HL
           LD E,[HL]
           LD A,E
           AND 7
           NEG
           ADD A, 8
           LD [IY+XDISP],A
           INC HL
           LD D,[HL]
           CALL PX_TO_PTRN_POS
           LD [IY+XP_BK],E
           INC HL
           LD E,[HL]
           LD A,E
           AND 7
           LD [IY+YDISP],A
           INC HL
           LD D,[HL]
           CALL PX_TO_PTRN_POS
           LD [IY+YP_BK],E
           LD HL,[WORK_BUFFER]
           LD DE,YP_BK+1
           ADD HL,DE
           LD D,[IY+YP_BK]
           LD E,[IY+XP_BK]
           LD BC,303h
           PUSH IX
           CALL GET_BKGRND
           POP IX
           JP PM2                ; Call rest of OS PUT_MOBILE routine

; The calling sequence for mobile objects is :
;
;           LD IX,HIGH_LEVEL_DEFINITION
;           LD HL,GRAPHICS
;           LD B,MODE
;           CALL PUTMOBILE

```

## OS 7' ROUTINES SPECIFICATIONS

*Written by Daniel Bienvenu and Steve Bégin.*

*Verified and completed with the ColecoVision programmers' manual. (in progress)*

## ***SOUND ROUTINES***

Except TURN\_OFF, the sound routines in the jump table require a specific sound data format and/or sound tables in RAM and ROM.

More information about the sound format, song data areas and more at the sections SOUND DATA FORMAT, SOUND TABLES, SONG TABLE IN ROM, OUTPUT TABLE IN RAM in pages 190-192.

A quick reference guide is available in page 22.



## FREQ\_SWEEP

### INPUT:

IX = address of byte 0 of a song data area.

### FUNCTION(S):

If frequency not swept, so decrement NLEN (note length) value and RET.

Otherwise,

- Decrement FPSV counter
- If FPSV timed out, then :
  - Reload FPSV counter and decrement NLEN value.
  - Add frequency step FSTEP to frequency value FREQ if note not over.

### OUTPUTS:

Z flag is reset if sweep in progress or note not over, Z flag is set if note over.

### CALLS:

DECLSN  
MSNTOLSN  
ADD816

### CALLED BY:

PROCESS\_DATA\_AREA

### NOTES:

None

## ATN\_SWEEP

### INPUT:

IX = address of byte 0 of a song data area.

### FUNCTION(S):

### OUTPUTS:

Z flag is set if sweep is over or note was never sweep, Z flag is reset sweep in progress.

### CALLS:

DECLSN  
MSNTOLSN

### CALLED BY:

PROCESS\_DATA\_AREA

### NOTES:

None

## UPATNCTRL

### INPUT:

IX = address of byte 0 of a song data area.

C = formatted channel attenuation code (MSN).

### FUNCTION(S):

Output attenuation or noise control data to sound port.

### OUTPUTS:

None

### CALLS:

None

### CALLED BY:

PLAY\_SONGS

TONE\_OUT

### NOTES:

None

## UPFREQ

### INPUT:

IX = address of byte 0 of a song data area.  
D = formatted channel frequency code (MSN).

### FUNCTION(S):

Output frequency data (into 2 bytes) to sound port.

### OUTPUTS:

None

### CALLS:

None

### CALLED BY:

TONE\_OUT

### NOTES:

None

## PT\_IX\_TO\_SxDATA

### INPUT:

B = song number.

### FUNCTION(S):

Point IX to byte 0 in a song data area calculated with song number (SONGNO) passed in B.

### OUTPUTS:

IX = address of byte 0 song data area used by that song number (SONGNO).

### CALLS:

None

### CALLED BY:

FREQ\_SWEEP

### NOTES:

DE = IX

HL is pointing to MSN SxDATA entry in LST\_OF\_SND\_ADDRS.

## LEAVE\_EFFECT

### INPUT:

B = song number.

### FUNCTION(S):

Restores the SONGNO to which the effect note belongs to B5-B0 of byte 0 in the effect's data area, and loads byte 1 and 2 with the address of the next note in the song. The address of the 1 byte SONGNO (saved by the effect when it was first called) is passed to DE. The 2 byte address of the next note in the song, also saved by the effect, is passed in HL. IX is assumed to be pointing to byte 0 of the data area to which the song number is to be restored. Bits 7 & 6 of the saved SONGNO byte are not stored into byte 0, and therefore may be used during the course of the effect to store any useful flag information.

### OUTPUTS:

None

### CALLS:

None

### CALLED BY:

Called by a special sound effect routine when it's finished.

### NOTES:

None

## AREA\_SONG\_IS

### INPUT:

IX = address of byte 0 of a song data area.

### FUNCTION(S):

Retrive in A the song # playing in a specific song data area pointed to by IX.

### OUTPUTS:

Accumulator =  
song # of the song using that area;  
FF if inactive;  
62 if special effect and HL = address of the special sound effect routine.

### CALLS:

None

### CALLED BY:

PROCESS\_DATA\_AREA

### NOTES:

None

## SOUND\_INIT

ADDRESS : 1FEE

INPUT:

HL = LST\_OF\_SND\_ADDRS, address in RAM to song data areas.  
B = # of song data areas to initialize.

FUNCTION(S):

Set pointer PTR\_TO\_LST\_OF\_SND\_ADDRS to LST\_OF\_SND\_ADDRS.  
Store inactive code FF at byte 0 of the song data areas.  
Store 00 at end of song data areas.  
Sets the 4 channel sound pointers to a dummy, inactive data area.  
Initialize SAVE\_CTRL to inactive code FF.  
Turn off sound

OUTPUTS:

None

CALLS:

ALL\_OFF (local routine name for TURN\_OFF\_SOUND)

CALLED BY:

Under user program control. Should be called immediately after power on.

NOTES:

IX and IY are preserved



## TURN\_OFF\_SOUND

ADDRESS : 1FD6

INPUT:

None

FUNCTION(S):

Turn off all 4 sound generators.

OUTPUTS:

None

CALLS:

None

CALLED BY:

POWER\_UP

NOTES:

Only the Accumulator is affected

## PLAY\_IT

ADDRESS : 1FF1

INPUT:

B = song number to play.

FUNCTION(S):

If the song is already playing, do nothing.

Otherwise,

- Load 1<sup>st</sup> note and set NEXT\_NOTE\_PTR.
- Update channel data pointers.

OUTPUTS:

None

CALLS:

PT\_IX\_TO\_SxDATA  
LOAD\_NEXT\_NOTE  
UP\_CH\_DATA\_PTRS

CALLED BY:

Under user program control

NOTES:

None

## SOUND\_MAN

ADDRESS : 1FF4

INPUT:

None

FUNCTION(S):

Update all song data areas.

- Update counters : decrement sound duration and sweep timers.
- Apply sound effect : modify swept frequency and attenuation values.
- Call special effects routines where necessary.
- Update the channel data area pointers if necessary.
- Restart the sound if indicated.

OUTPUTS:

None

CALLS:

PT\_IX\_TO\_SxDATA  
PROCESS\_DATA\_AREA

CALLED BY:

Under user program control. Should be called every VDP interrupt, after PLAY\_SONGS.

NOTES:

None

## UP\_CH\_DATA\_PTRS

### INPUT:

None

### FUNCTION(S):

Set all 4 channel data pointers to dummy inactive area.  
Scan all song data areas to store song data area's byte 0 address to proper channel data pointer.

### OUTPUTS:

None

### CALLS:

PT\_IX\_TO\_SxDATA

### CALLED BY:

JUKE\_BOX (local routine name for PLAY\_IT)  
EFXOVER (sub-routine in PROCESS\_DATA\_AREA)

### NOTES:

IX returned intact

## PROCESS\_DATA\_AREA

### INPUT:

IX = address of byte 0 of a song data area.

### FUNCTION(S):

If byte 0 is inactive code FF, do nothing.

If byte 0 is special sound effect code 3E, do 1 pass thru effect.

Otherwise, process attenuation and frequency sweep data, if any.

If note is over, run sub-routine EFXOVER.

### OUTPUTS:

None

### CALLS:

AREA\_SONG\_IS

ATN\_SWEEP

FREQ\_SWEEP

EFXOVER

### CALLED BY:

SND\_MANAGER (local routine name for SOUND\_MAN)

### NOTES:

None

## EFXOVER

### INPUT:

IX = address of byte 0 of a song data area.

### FUNCTION(S):

Load next note and update channel data pointers if needed.

### OUTPUTS:

None

### CALLS:

LOAD\_NEXT\_NOTE  
UP\_CH\_DATA\_PTRS

### CALLED BY:

PROCESS\_DATA\_AREA

### NOTES:

None

## PLAY\_SONGS

ADDRESS : 1F61

INPUT:

None

FUNCTION(S):

Prepare and pitch the actual song notes to sound chip.

- Current frequency and attenuation data is output to each tone generator, if sound on that channel is active; otherwise that generator is turned off.
- Noise generator is sent current attenuation data and control data, if new.
- Modifies SAVE\_CTRL if necessary

OUTPUTS:

None

CALLS:

TONE\_OUT  
UPATNCTRL  
UPFREQ

CALLED BY:

Under user program control. Should be called every VDP interrupt, before SOUND\_MAN.

NOTES:

None

## TONE\_OUT

### INPUT:

IX = pointer to byte 0 of a song data area

A = formatted channel mute code

C = formatted channel attenuation code (needed for UPATNCTRL) (MSN)

D = formatted channel frequency code (needed for UPFREQ) (MSN)

### FUNCTION(S):

Pitch the current frequency and attenuation to sound chip.

### OUTPUTS:

None

### CALLS:

UPATNCTRL

UPFREQ

### CALLED BY:

PLAY\_SONGS

### NOTES:

None



## LOAD\_NEXT\_NOTE\*

### INPUT:

IX = pointer to byte 0 of a song data area

### FUNCTION(S):

Update song data area based on next note code.

### OUTPUTS:

None

### CALLS:

JUKE\_BOX (local name for PLAY\_IT)

Note: is called only to reload 1<sup>st</sup> note when reading a REPEAT note code.

### CALLED BY:

PLAY\_IT  
EFXOVER

### NOTES:

AF , HL, DE, BC and IY are affected. Additional may be changed by called special effect subroutines.

## QUICK REFERENCE: HOW TO USE THE OS 7' SOUND ROUTINES

When needed, usually before playing game, turn off sound with the following routine :

TURN\_OFF\_SOUND (1FD6) : Turn off all sound channels. No setup required.

Setup the sound tables in RAM as soon as possible in your code with the following routine :

SOUND\_INIT (1FEE) : Initialize sound tables in CPU RAM.

Input : HL = Address of the song table, B = Number of output tables to be used.

Note: The first entry in the song table (in the game code) contains the address of the 1<sup>st</sup> song data area in RAM.

During the game, use the following routine to play sounds :

PLAY\_IT (1FF1) : Play a specific song or sound effect.

Input : B = Song number to be started

And, to play songs at a regular speed, add the following routines in this order in the user NMI routine :

PLAY\_SONGS (1F61) : Pitch data to sound generator chip.

SOUND\_MAN (1FF4) : Update sound tables by applying sweep effects, loading next note or set the END flag.

The song table in ROM is composed into many entries of two addresses (a pointer to the song data in ROM and a pointer to the song data area in RAM). Each entry correspond to a song. The 1<sup>st</sup> entry in the song table have to use obligatory a pointer to the 1<sup>st</sup> song data area. The memory allocation to a free zone in RAM for the song data areas is the responsibility of the coder. Because the sound chip can't play more than one song on the same sound channel, there is a concept of priority : higher is the number of the song data area, higher is the priority.

Each song in ROM is encoded into a specific sound data format, uses only one channel, and obligatory ends with an END or REPEAT code. To play a music that uses more than one sound channel, the coder have to encode his music into separate song entries, one for each sound channel needed, of course that needs more than one song entry in the song table where each entry uses a different song data area.

Expert tips : To stop a song playing, you can play another song that uses the same song data area, or write the INACTIVE code 0FFh at the 1<sup>st</sup> byte of its song data area.

## ***OBJECT ROUTINES***

The following routines are for objects. An object can be represented as a set of characters and/or sprites.

Note: Almost every Non-Coleco programmers didn't use these routines. Object graphic is a good concept but these routines are complex, slow, need too much RAM space.

## ACTIVATE

ADDRESS : 1FF7

INPUT:

HL = pointer to the object data.  
Carry flag = is set to move graphic data to VRAM, reset otherwise.

FUNCTION(S):

Initialize the RAM status area for the passed object  
If carry flag is set, move object pattern and color generators to the PATTERN and COLOR generator tables in VRAM.

OUTPUTS:

None

CALLS:

PUT\_VRAM\_ (local name for PUT\_VRAM)  
VRAM\_WRITE (local name for WRITE\_VRAM)

CALLED BY:

Under user program control

NOTES:

VDP\_MODE\_WORD (73C3), WORK\_BUFFER (8006) may be needed by called subroutines.  
AF , HL, DE, BC and IY are affected. Additional may be changed by called subroutines.

OBJECT HEADER : pointer to OBJ GEN CPU ROM, pointer to OBJ CPU RAM.  
The OBJ GEN CPU ROM header starts with less significant nibble (LSN) as OBJ TYPE.  
OBJ TYPE : 0=semi mobile, 1=mobile, 2=0sprite, 3=1sprite, other=complex.

**\*\*BUG\*\*** Error in subroutine for semi-mobile type objects in graphic mode I.

## SET\_UP\_WRITE

### INPUT:

IX = data pointer.  
B = parameter.

### FUNCTION(S):

Sets up deferred VRAM operation.

### OUTPUTS:

None

### CALLS:

None

### CALLED BY:

PUTOBJ

### NOTES:

Destroys all.

## INIT\_WRITER

ADDRESS : 1FE5

INPUT:

A = size of the deferred write queue.

HL = location in RAM of the deferred write queue.

FUNCTION(S):

Initialize deferred write queue in RAM :

- QUEUE\_SIZE (73CA) = A
- QUEUE\_HEAD (73CB) = 0
- QUEUE\_TAIL (73CC) = 0
- HEAD\_ADDRESS (73CD-73CE) = HL
- TAIL\_ADDRESS (73CF-73D0) = HL

OUTPUTS:

None

CALLS:

None

CALLED BY:

Under user program control

NOTES:

Only the Accumulator is affected

## WRITER

ADDRESS : 1FE8

INPUT:

None.

FUNCTION(S):

Temporary reset deferred write flag and write data at queue to VRAM.

OUTPUTS:

None

CALLS:

DO\_PUTOBJ

CALLED BY:

Under user program control

NOTES:

Destroys all.

## PUTOBJ

ADDRESS : 1FFA

### DESCRIPTION:

According to flag DEFER\_WRITES (73C6), this function updates the object specifications (position x/y, pattern, color) of object IX on screen or puts the object in the queue for updating later.

### INPUT:

IX = Object data pointer

B = Object parameter, selector for methods of combining object generators with background generators (for mobile objects only)

### FUNCTION(S):

Check if DEFER\_WRITES flag (73C6) is true.

If true, set up for deferred write by calling SET\_UP\_WRITE

If not, process object by calling DO\_PUTOBJ

### OUTPUTS:

None

### CALLS:

SET\_UP\_WRITE

DO\_PUTOBJ

### CALLED BY:

Under user program control

### NOTES:

Assume this routine destroys all registers.



## DO\_PUTOBJ

### INPUT:

IX = Object data pointer.

### FUNCTION(S):

Get object graphics address and object type.

Call the appropriate put object routine based on object type.

### OUTPUTS:

None

### CALLS:

PUTSEMI  
PUT0SPRITE  
PUT1SPRITE  
PUT\_MOBILE  
PUTCOMPLEX

### CALLED BY:

WRITER  
PUTOBJ

### NOTES:

Assume this routine destroys all registers.

## PUTSEMI

### DESCRIPTION:

Puts semi-mobile objects on screen. A semi-mobile object is a box of names (characters) that can be positioned anywhere on screen.

### FUNCTION(S):

It calls PX\_TO\_PTRN\_POS and CALC\_OFFSET to calculate the top-left current screen XY position of the box of chars in RAM.

Checks if chars that will be overwritten must be saved (OLD\_SCREEN in Semi Object Table.)

If Yes (< 8000h):

It recalls the names (characters) that were overwritten the last time (if present) from RAM (OLD\_SCREEN) and put them back on screen..

It calls GET\_BKGRND to save the names (characters) that the new box will overwrite in RAM (again, 3<sup>rd</sup> word in Semi Object Table.)

It finally writes new box of names (characters) on screen by calling PUT\_VRAM.

Notes: OLD\_SCREEN can be in RAM (7100h to 7FFFh) or in VRAM (0000h-3FFFh).

Be sure to use the ranges of addresses specified here (possibility of problems).

If using VRAM for OLD\_SCREEN, it uses the WORK\_BUFFER (8006) pointer for temporary storage.

Else (>= 8000)

Only write new box of names (characters) on screen by calling PUT\_VRAM

## PX\_TO\_PTRN\_POS

### INPUT:

DE = signed 16bit number.

### FUNCTION(S):

Divides DE reg by 8,

If signed result > 127 then E = max signed positive number 127.

If signed result < -128 then E = min negative number -128.

### OUTPUTS:

$E = DE/8$ , except if  $DE/8 < -128$  or  $DE/8 > 127$  then E equals respectively -128 or 127.

### CALLS:

None.

### CALLED BY:

PUTSEMI

PUT\_MOBILE

### NOTES:

HL is restored.

## PUT\_FRAME

### DESCRIPTION:

Puts a box of names (characters) on screen. It prevents bleeding outside visible screen.

### INPUT:

HL = address of list of names (characters that compose the frame)  
E = X\_PAT\_POS  
D = Y\_PAT\_POS  
C = X\_EXTENT  
B = Y\_EXTENT

### FUNCTION(S):

The names which constitute a frame are moved to the name table in VRAM.  
The upper left hand corner of the frame is positioned at X\_PAT\_POS, Y\_PAT\_POS.

### OUTPUTS:

None.

### CALLS:

CALC\_OFFSET  
PUT\_VRAM

### CALLED BY:

PUTSEMI  
PUT\_MOBILE

### NOTES:

## GET\_BKGRND

### DESCRIPTION:

Gets a box of names (characters) from screen.

### INPUT:

HL = location in CPU RAM to copy names from VRAM  
E = X\_PAT\_POS  
D = Y\_PAT\_POS  
C = X\_EXTENT  
B = Y\_EXTENT

### FUNCTION(S):

Gets the names from name table which constitute the background in which an object is to be moved at X\_PAT\_POS, Y\_PAT\_POS.

### OUTPUTS:

None.

### CALLS:

CALC\_OFFSET  
GET\_VRAM

### CALLED BY:

PUTSEMI  
PUT\_MOBILE

### NOTES:

## CALC\_OFFSET

### INPUT:

D = Y\_PAT\_POS.  
E = X\_PAT\_POS.

### FUNCTION(S):

This routine calculate the proper offset into the name table for the pattern position given by X\_PAT\_POS, Y\_PAT\_POS. The formula used is :  $\text{offset} = 32 * Y\_PAT\_POS + X\_PAT\_POS$

### OUTPUTS:

DE = offset.

### CALLS:

None.

### CALLED BY:

PUT\_FRAME  
GET\_BKGRND

### NOTES:

DE is affected.

PUT0SPRITE

PUT1SPRITE



PUT\_MOBILE

PUTCOMPLEX

## TIMER ROUTINES

The users have to reserve two free RAM spaces to use timers. The first RAM space is for the timer table itself, the second one is for extra data block needed for repeating long timers. The following data structures are how the timers look like in RAM.

General timer data structure (3 bytes) :

| TIMER |        |      |     |      |   |   |   |
|-------|--------|------|-----|------|---|---|---|
| DONE  | REPEAT | FREE | EOT | LONG | - | - | - |
| ?     |        |      |     |      |   |   |   |
| ?     |        |      |     |      |   |   |   |

Specific timer data structures :

| ONE-TIME SHORT TIMER   |   |   |   |   |   |   |   |
|------------------------|---|---|---|---|---|---|---|
| DONE                   | 0 | 0 | 0 | 0 | - | - | - |
| Unsigned counter value |   |   |   |   |   |   |   |
| -                      |   |   |   |   |   |   |   |

| REPEATING SHORT TIMER           |   |   |   |   |   |   |   |
|---------------------------------|---|---|---|---|---|---|---|
| DONE                            | 1 | 0 | 0 | 0 | - | - | - |
| Unsigned current counter value  |   |   |   |   |   |   |   |
| Unsigned original counter value |   |   |   |   |   |   |   |

| ONE-TIME LONG TIMER                    |   |   |   |   |   |   |   |
|----------------------------------------|---|---|---|---|---|---|---|
| DONE                                   | 0 | 0 | 0 | 1 | - | - | - |
| Unsigned counter value - low-part LSB  |   |   |   |   |   |   |   |
| Unsigned counter value - high-part MSB |   |   |   |   |   |   |   |

| REPEATING LONG TIMER                                   |   |   |   |   |   |   |   |
|--------------------------------------------------------|---|---|---|---|---|---|---|
| DONE                                                   | 1 | 0 | 0 | 1 | - | - | - |
| Pointer to a data block<br>for extra timer information |   |   |   |   |   |   |   |

| DATA BLOCK                                      |  |  |  |  |  |  |  |
|-------------------------------------------------|--|--|--|--|--|--|--|
| Unsigned current counter value - low-part LSB   |  |  |  |  |  |  |  |
| Unsigned current counter value - high-part MSB  |  |  |  |  |  |  |  |
| Unsigned original counter value - low-part LSB  |  |  |  |  |  |  |  |
| Unsigned original counter value - high-part MSB |  |  |  |  |  |  |  |

Note: The following routines have been done by Ken Lagace and Rob Jepson in March '82.

## TIME\_MGR

ADDRESS : 1FD3

INPUT:

None.

FUNCTION(S):

Get timer table address from TIMER\_TABLE\_BASE (73D3-73D4).  
Update all timers in timer table.

OUTPUTS:

None.

CALLS:

None.

CALLED BY:

Under user program control

NOTES:

DE and HL are affected.

## INIT\_TIMER

ADDRESS : 1FC7

INPUT:

HL = base address in CPU RAM for timer table.

DE = base address in CPU RAM for data block.

FUNCTION(S):

Store given base address for timer table in TIMER\_TABLE\_BASE (73D3-73D4) and for data block in NEXT\_TIMER\_DATA\_BYTE (73D5-73D6).

OUTPUTS:

None.

CALLS:

None.

CALLED BY:

Under user program control

NOTES:

DE and HL are switched.

## FREE\_SIGNAL

ADDRESS : 1FCA

INPUT:

A = signal (timer) number to be freed. 0 = 1<sup>st</sup> signal, 1 = 2<sup>nd</sup> signal, etc.

FUNCTION(S):

Finds signal (timer) A, stops it by setting bit 5 (FREE) and release its data block if exists.

OUTPUTS:

None.

CALLS:

None.

CALLED BY:

Under user program control

NOTES:

## REQUEST\_SIGNAL

ADDRESS : 1FCD

INPUT:

HL = length of timer

A = repeating timer if 0, non repeating type if not.

FUNCTION(S):

Search for a free signal (timer) and initialize it with HL and A.

Return signal (timer) number used in A.

OUTPUTS:

A = signal (timer) number.

CALLS:

None.

CALLED BY:

Under user program control

NOTES:

## TEST\_SIGNAL

ADDRESS : 1FD0

INPUT:

A = signal (timer) number to be tested.

FUNCTION(S):

Check if the signal (timer) number exists.

If so, return A = true if bit 7 (DONE) is set and free up the signal (timer) if non repeating counter.

Otherwise, return A = false

OUTPUTS:

A = true if signal bit 7 (DONE) is set, false otherwise.

CALLS:

None.

CALLED BY:

Under user program control

NOTES:

Destroys BC and HL.



## ***CONTROLLER ROUTINES***

## CONTROLLER\_INIT

### INPUT:

None

### FUNCTION(S):

Initialize controller to strobe reset.

Clear controller memory and debounce status buffer.

Clear remaining variables :

- SPIN\_SW0\_CT (73EB) : Spinner counter port #1
- SPIN\_SW1\_CT (73EC) : Spinner counter port #2
- S0\_C0 (73EE) : Segment #0 data, port #1
- S0\_C1 (73EF) : Segment #0 data, port #2
- S1\_C0 (73F0) : Segment #1 data, port #1
- S1\_C1 (73F1) : Segment #1 data, port #2

### OUTPUTS:

None

### CALLS:

None

### CALLED BY:

POWER\_UP

### NOTES:

CONTROLLER\_MAP (8008), DBNCE\_BUFF (73D7-73D8) are needed.  
A, B, IX, IY are affected.

## CONT\_READ

### INPUT:

H = 0 for player #1, 1 for player #2.

### FUNCTION(S):

Return the complement value of the controller port H segment 0 data (joystick data).

### OUTPUTS:

A = Raw data from controller H

### CALLS:

None

### CALLED BY:

DECODER

### NOTES:

Because the returned value in register A is the complement of the controller port data, bits 1 mean data, bits 0 mean no data.  
Only register A is affected.

## CONTROLLER\_SCAN

ADDRESS : 1F76

INPUT:

None

FUNCTION(S):

Update SO\_CO, S0\_C1, S1\_C0, S1\_C1 by reading segment 0 and 1 from both controller ports.

OUTPUT:

None

CALLS:

None

CALLED BY:

POLLER or under user program control.

NOTES:

Because the returned value in register A is the complement of the controller port data, bits 1 mean data, bits 0 mean no data.  
Destroys A

## UPDATE\_SPINNER

ADDRESS : 1F88

INPUT:

None

FUNCTION(S):

Update counters pointed by SPIN\_SW0\_CT and SPIN\_SW1\_CT by reading bit 4 and 5 from segment 1 of both controller ports.

OUTPUT:

None

CALLS:

None

CALLED BY:

Under user program control.

NOTES:

Destroys A, HL

## DECODER

ADDRESS : 1F79

INPUT:

H = Controller number (0 for player #1, 1 for player #2)

L = Segment number (0 for fire+joystick, 1 for arm+keyboard)

FUNCTION(S):

If L = segment number 0

- Load spinner counter SPIN\_SW0\_CT or SPIN\_SW1\_CT in E
- Call CONT\_READ
- Load joystick data in L (A AND 0F)
- Load Fire state in H (A AND 40)

Else L = segment number 1

- Call CONT\_READ
- Load decoded key value in L (0 = key 0, ..., 9 = key 9, A = key \*, B = key #, F = no key)
- Load Arm state in H (A AND 40)

OUTPUT:

H = State of Fire (if segment number = 0), Arm (if segment number = 1)

L = State of Joystick (if segment number = 0), Keyboard (if segment number = 1)

E = Spinner (if segment number = 0)

CALLS:

None

CALLED BY:

Under user program control.

NOTES:

Destroys All

## ***MISCELLANEOUS***

## BOOT\_UP

ADDRESS : 0000

INPUT:

None

FUNCTION(S):

Set stack (= 073B9h)

Continue the execution by calling POWER\_UP

OUTPUTS:

None

CALLS:

POWER\_UP

CALLED BY:

RESET or POWER ON

NOTES:

None



## RAND\_GEN

ADDRESS : 1FFD

INPUT:

None

FUNCTION(S):

Set of bit operations on RAND\_NUM to calculate next pseudo random value.

OUTPUTS:

HL = (RAND\_NUM)  
A = L

CALLS:

None

CALLED BY:

Under user program control

NOTES:

None

## POWER\_UP

### INPUT:

None

### FUNCTION(S):

Check for the presence of a game cartridge (at 08000h)  
If cartridge (rom) first two bytes are 055h and 0AAh, then start game immediately.  
Otherwise,

- Turn off sound
- Initialize pseudo random
- Initialize controller to strobe reset
- Set no deferred writes to VRAM
- Set no sprites multiplexing
- Continuing the execution by displaying the logo screen

### OUTPUTS:

None

### CALLS:

TURN\_OFF\_SOUND  
CONTROLLER\_INIT  
DISPLAY\_LOGO

### CALLED BY:

BOOT\_UP

### NOTES:

None

## DECLSN

ADDRESS : 0190

INPUT:

HL = pointer to a byte value.

FUNCTION(S):

Decrement low nibble (LSN) of a byte pointed to by HL without affecting the high nibble part (MSN).

OUTPUTS:

(HL) = old MSN | new LSN

Z flag set if decrement LSN results in 0, reset otherwise.

C flag set if decrement LSN results in -1 (F), reset otherwise.

A = 0 | new LSN

CALLS:

None

CALLED BY:

FREQ\_SWEEP

ATN\_SWEEP

NOTES:

HL is preserved

## DECMSN

ADDRESS : 019B

INPUT:

HL = pointer to a byte value.

FUNCTION(S):

Decrement high nibble (MSN) part of a byte pointed to by HL without affecting the low nibble part (LSN).

OUTPUTS:

(HL) = new MSN | old LSN

Z flag set if decrement MSN results in 0, reset otherwise.

C flag set if decrement MSN results in -1 (F), reset otherwise.

A = 0 | new MSN

CALLS:

None

CALLED BY:

None

NOTES:

HL is preserved

## MSNTOLSN

ADDRESS : 01A6

INPUT:

HL = pointer to a byte value.

FUNCTION(S):

Copy high nibble (MSN) part of a byte value pointed to by HL to the low nibble part (LSN) of that byte.

OUTPUTS:

(HL) = MSN | MSN

CALLS:

None

CALLED BY:

FREQ\_SWEEP  
ATN\_SWEEP

NOTES:

HL is preserved

## ADD816

ADDRESS : 01B1

INPUT:

HL = pointer to a word value.

A = signed byte value [-128,127].

FUNCTION(S):

Adds 8 bit two's complement signed value passed in A to the 16 bit value pointed to by HL.

OUTPUTS:

$(HL) = (HL) + A$

CALLS:

None

CALLED BY:

FREQ\_SWEEP

NOTES:

HL is returned intact

## DISPLAY\_LOGO

### DESCRIPTION:

Displays the Coleco logo screen with COLECOVISION on a black background. If no cartridge is detected, a default message is displayed during 60 seconds, instructing the operator to turn game off before inserting cartridge or expansion module. Otherwise, the game title, manufacturer, and copyright year are obtained from the cartridge, and overlayed onto the logo screen for a period of 10 seconds before game starts.

### INPUT:

None

### FUNCTION(S):

- Clean up the 16K VRAM (0000h-4000h)
- Set default screen mode 1 by calling MODE\_1
- Load default ASCII by calling LOAD\_ASCII
- Load logo pattern
- Put logo on screen
- Add <sup>™</sup> beside the logo
- Put year 1982 centered at the bottom
- Load logo colors
- Enable display
- Test if a cartridge is present :
  - 1. If it's present,
    - Add game informations from cartridge to screen (title, company, year)
    - Wait 10 seconds
    - Turn off display and start game
  - 2. Otherwise, display default message during 60 seconds then turn off display

### OUTPUTS:

None

### CALLS:

- FILL\_VRAM
- PUT\_VRAM
- WRITE\_REGISTER
- MODE\_1
- LOAD\_ASCII
- (START\_GAME)

### CALLED BY:

POWER\_UP

### NOTES:

None

## OS 7' ABSOLUTE LISTING

*OS 7' Listing from the ColecoVision Programmers' Manual rev. 5 © Coleco Industries, Inc. 1982  
Disassembled with DASMx v1.30 © Copyright 1996-1999 Conquest Consultants.  
Restored by Daniel Bienvenu October, 2004.*



## OPERATING SYSTEM

```

;      Author:      Coleco Industries Inc.
;                  Advanced Research & Development - Software Engineering
;
;      UserID:      OS
;
;      Starting date:      A long long time ago in a galaxy far far away . . .
;
;      Prom release date:  24 Nov 1982. For internal use only
;      Prom release rev:   7B
;
;      Prom release date:  December 28, 1982
;      Prom release rev:   7PRIME
;
;      Header Rev: 2
;
; *****
; *
; *      ColecoVision Operating System
; *      Absolute Listing ( REV 7PRIME )
; *      © Coleco Industries 1982
; *
; *      *** Confidential ***
; *
; *****
;
;      This listing has the actual address of the start of OS routines
;
;      Rev History (one line note indicating the change)
;
;      Rev.   Date           Change
;      4      14feb1983      Filler locations changed to 0FFH to
;                               reflect OS_7PRIME. Prom release date
;                               changed to December 28, 1982 from May
;                               1982. Name change to OS_7PRIME to
;                               reflect majority of versions in the
;                               field at this date.
;
;      3      24nov1982      Timing change to shorten LOGO delay
;                               Title changes to JMPTABLES and OSSR_EQU
;
;      2      6oct1982       Minor comment modifications
;
;      1      23sept1982     OS_7 as one absolute file
;
;      0      may 1982       OS_7 listing by module
;
; =====
; =                                EXPORTS                                =
; =====
;
; * ENTRY POINTS TO OS ROUTINES
;
;      GLB      INIT_TABLE           ; TABLE MANAGER
;      GLB      GET_VRAM
;      GLB      PUT_VRAM
;      GLB      INIT_SPR_ORDER
;      GLB      WR_SPR_NM_TBL
;      GLB      INIT_TABLEP         ; PASCAL CALLS
;      GLB      GET_VRAMP

```

```

;      GLB      PUT_VRAM
;      GLB      INIT_SPR_ORDERP
;      GLB      WR_SPR_NM_TBLP
;
;      GLB      WRITE_REGISTER          ; VIDEO DRIVERS
;      GLB      READ_REGISTER
;      GLB      WRITE_VRAM
;      GLB      READ_VRAM
;      GLB      INIT_WRITER
;      GLB      WRITER
;      GLB      WRITE_REGISTERP        ; PASCAL CALLS
;      GLB      WRITE_VRAMP
;      GLB      READ_VRAMP
;      GLB      INIT_WRITERP
;
;      GLB      POLLER                  ; CONTROLLER ROUTINES
;      GLB      UPDATE_SPINNER
;      GLB      CONTROLLER_SCAN
;      GLB      DECODER
;
;      GLB      SOUND_INIT              ; SOUND ROUTINES
;      GLB      TURN_OFF_SOUND
;      GLB      PLAY_IT
;      GLB      SOUND_MAN
;      GLB      PLAY_SONGS
;      GLB      SOUND_INITP            ; PASCAL CALLS
;      GLB      PLAY_ITP
;
;      GLB      INIT_TIMER              ; TIME MGMT ROUTINES
;      GLB      FREE_SIGNAL
;      GLB      REQUEST_SIGNAL
;      GLB      TEST_SIGNAL
;      GLB      TIME_MGR
;      GLB      INIT_TIMERP            ; PASCAL CALLS
;      GLB      FREE_SIGNALP
;      GLB      REQUEST_SIGNALP
;      GLB      TEST_SIGNALP
;
;      GLB      STACK                  ; MISC GLOBALS
;      GLB      VDP_STATUS_BYTE
;      GLB      VDP_MODE_WORD
;      GLB      AMERICA
;      GLB      MUX_SPRITES
;      GLB      DEFER_WRITES
;      GLB      RAND_GEN                ; Can be called from PASCAL or ASM language
;
;      GLB      PUTOBJ                  ; GRAPHICS ROUTINES
;      GLB      ACTIVATE
;      GLB      REFLECT_VERTICAL
;      GLB      REFLECT_HORIZONTAL
;      GLB      ROTATE_90
;      GLB      ENLARGE
;      GLB      PUTOBJP                ; PASCAL CALLS
;      GLB      ACTIVATEP
;
;      GLB      GAME_OPT                ; GAME OPTIONS DISPLAY
;      GLB      LOAD_ASCII              ; LOADS ASCII CHARACTER GENERATORS
;      GLB      FILL_VRAM                ; FILLS DESIGNATED AREA OF VRAM WITH VALUE
;      GLB      MODE_1                  ; SETS UP A DEFAULT GRAPHICS MODE 1
;      GLB      ASCII_TABLE             ; POINTER TO TABLE OF ASCII GENERATORS
;      GLB      NUMBER_TABLE            ; POINTER TO TABLE OF 0-9 PATTERN GENERATORS
;
;      =====

```

```

; =                                     CARTRIDGE ROM DATA AREA                                     =
; =====
;
CARTRIDGE          EQU    08000H
; This is the memory location tested to see if a cartridge is plugged
; in. If it contains the pattern AA55H the OS assumes that a game
; cartridge is present. If it contains the pattern 55AAH, the OS
; assumes that a test cartridge is present (bypass Coleco logo screen).
;
LOCAL_SPR_TABLE    EQU    08002H
; This is a pointer to the CPU RAM copy of the sprite name table. The
; table copy is used whenever one level of indirection is desired in
; addressing the VRAM table. For example when using the OS sprite
; multiplexing software.
;
SPRITE_ORDER       EQU    08004H
; This is a pointer to the CPU RAM sprite order table. This table is
; used to order the local sprite name table.
;
WORK_BUFFER        EQU    08006H
; This is a pointer to a free buffer space in RAM. The object oriented
; graphics routines used this buffer for temporary storage.
;
CONTROLLER_MAP     EQU    08008H
; This is a pointer to the controller memory map that is maintained by
; the high-level controller scanning and debounce software.
;
START_GAME         EQU    0800AH
; This is a pointer to the start of the game
;
; =====
; =                                     RESTART AND INTERRUPT VECTORS                                     =
; =====
;
RST_8H_RAM         EQU    0800CH
; This is the restart 8 soft vector.
;
RST_10H_RAM        EQU    0800FH
; This is the restart 10 soft vector.
;
RST_18H_RAM        EQU    08012H
; This is the restart 18 soft vector.
;
RST_20H_RAM        EQU    08015H
; This is the restart 20 soft vector.
;
RST_28H_RAM        EQU    08018H
; This is the restart 28 soft vector.
;
RST_30H_RAM        EQU    0801BH
; This is the restart 30 soft vector.
;
IRQ_INT_VECTOR     EQU    0801EH
; This is the maskable interrupt soft vector.
;
NMI_INT_VECTOR     EQU    08021H
; This is the non maskable interrupt (NMI) soft vector.
;
GAME_NAME          EQU    08024H
; From here to START_GAME there should be a string of ASCII characters
; names that has the following form:
;
;     NAME_OF_THIS_GAME/MAKER_OF_THIS_GAME/COPYWRITE_YEAR.

```

```

;
;   For example:
;
;       "DONKEY KONG/NINTENDO/1982"
;
; IMPORTANT NOTE *****
;
;       **** IT IS THE RESPONSIBILITY OF THE ****
;       **** CARTRIDGE PROGRAMMER TO PLACE ****
;       **** THESE CODES IN CARTRIDGE ROM ****
;
; =====
; =                      OPERATING SYSTEM ROM CODE                      =
; =====
;
; ***** PAGE ZERO *****
; * PAGE ZERO CONTAINS THE RESTART VECTORS, INTERRUPT VECTORS, AND
; * THE INTERRUPT VECTORING SOFTWARE, AS WELL AS THE DEFAULT HANDLERS
; * FOR INTERRUPTS AND RESTARTS.
;
;   .IDENT OS           ;includes BOOT_UP,RAND_GEN_,PARAM_
;
; #Globals
;   GLB    BOOT_UP,RAND_GEN_,PARAM_
;
; #Externals
;   EXT    TURN_OFF_SOUND,CONTROLLER_INIT,DISPLAY_LOGO
;
; INCLUDE    OSSR_EQU:OS:0 ;equates
;
; #Defines
STACK          EQU    073B9H
DEFER_WRITES   EQU    073C6H
MUX_SPRITES    EQU    073C7H
RAND_NUM       EQU    073C8H
;
; BOOT-UP ROUTINE
;
; The BOOT-UP routine handles power on resets and restarts to 0.
; It initializes the stack and jumps to the POWER_UP routine.
;
BOOT_UP:
;   * Kick stack
;       ld    sp,STACK
;   * jump to POWER_UP
;       jp    POWER_UP
;
filler_0006:
;       db    0FFH,0FFH
;
;
; RESTART VECTORS
;
; The following are the 8 programmable restarts. For each of the
; restart locations below there is a vector in cartridge ROM.
; To use a restart, the programmer must place the address of the
; routine which he/she wishes to access through the restart at the
; corresponding vector. Thereafter every time that restart is
; executed, the cartridge programmer's routine will be called.
;
RST_8H:
;       jp    RST_8H_RAM
;

```

```

filler_000B:
    db    0FFH,0FFH,0FFH,0FFH,0FFH
;
RST_10H:
    jp    RST_10H_RAM
;
filler_0013:
    db    0FFH,0FFH,0FFH,0FFH,0FFH
;
RST_18H:
    jp    RST_18H_RAM
;
filler_001B:
    db    0FFH,0FFH,0FFH,0FFH,0FFH
;
RST_20H:
    jp    RST_20H_RAM
;
filler_0023:
    db    0FFH,0FFH,0FFH,0FFH,0FFH
;
RST_28H:
    jp    RST_28H_RAM
;
filler_002B:
    db    0FFH,0FFH,0FFH,0FFH,0FFH
;
RST_30H:
    jp    RST_30H_RAM
;
filler_0033:
    db    0FFH,0FFH,0FFH,0FFH,0FFH
;
; MASKABLE INTERRUPT VECTORING SOFTWARE
;
; A maskable interrupt occurring in the system is equivalent to a
; restart to 38H. Thus, the maskable interrupt is vectored in exactly
; the same way as the various restarts given above. In order to use
; the interrupt, the cartridge must place the address of his/her
; interrupt handler in the IRQ_INT_VECT location in cartridge ROM.
;
; The cartridge programmer is responsible for saving any registers
; his/her own interrupt handlers may use, and for re-enabling
; interrupts if he/she needs to be re-enabled.
;
IRQ_INTERRUPT:
    jp    IRQ_INT_VECT
;
; =====
; =                                RANDOM NUMBER GENERATOR                                =
; =====
;
; (PLACED HERE FOR PURPOSES OF CODE COMPACTION)
;
; Random number generator (pseudo) for a 16 bit value
; This routine 'exclusive or's the 15th and 8th bit
; together. It then rotates the entire quantity to the
; left and inserts the 'exclusive or'ed bit into the
; rightmost bit. Upon leaving it stores the random number
; in a specified memory location.
;
; The random number can be accessed from the global location
; RAND_NUM or the HL pair or the Accumulator.

```

```

;
RAND_GEN:
    ld    hl, (RAND_NUM)
    bit   7,h
    jr    z,NOT_ON
    bit   0,h
    jr    z,SET
    jr    RESET
;
NOT_ON:
    bit   0,h
    jr    z,RESET
SET:
    scf
    jr    CARRY_READY
;
RESET:
    or     a
CARRY_READY:
    rl     l
    rl     h
    ld     (RAND_NUM),hl
    ld     a,l
    ret
;
filler_0059:
    db     0FFH,0FFH,0FFH,0FFH,0FFH
    db     0FFH,0FFH,0FFH,0FFH,0FFH
    db     0FFH,0FFH,0FFH
;
; THE NMI VECTORING SOFTWARE AND DEFAULT HANDLER
;
; When an NMI is raised by the VDP in the ColecoVision system, it
; causes the CPU to restart to 66h. The vectoring software for the
; NMI is identical to that for the maskable interrupt except that
; it gets its vector from NMI_INT_VECT instead of IRQ_INT_VECT.
;
; Again the cartridge programmer is responsible, in his/her own
; interrupt handlers for saving and restoring the processor state
; when necessary, and for cleaning the VDP condition by reading the
; VDP status register.
;
NMI_INTERRUPT:
    jp     NMI_INT_VECT
;
; =====
; =                                     OS ROM DATA AREA                                     =
; =====
;
AMERICA:
    db     60
; This byte should be used whenever the cartridge programmer wants to
; set up real-time counters. It has a value of 60 for ColecoVisions
; marketed in the USA and 50 for european untis. Use of this byte
; ensures cartridge compatibility at least where real-time counting
; is concerned
;
ASCII_TABLE:
    dw     ASCII_TBL
; This is the address of the Rom pattern generators for uppercase
; ASCII which are contained within the operating system.
;
NUMBER_TABLE:

```

```

        dw      NUMBER_TBL
; This is the address of the ROM pattern generators for the numbers
; 0-9 which are contained within the operating system.
;
; ***** POWER ON BOOT SOFTWARE *****
; BOOT_UP      SINCE THE VIDEO GAME SYSTEM MAY BE STARTED UP WITH A
;              GAME CARTRIDGE, KEYBOARD MODULE, OR BOTH (OR NOTHING)
;              INSTALLED AT BOOT UP, THE SOFTWARE MUST PERFORM THE
;              FOLLOWING:
;              A.  INITIALIZE THE INTERRUPT VECTORS.
;              B.  INITIALIZE RESTART VECTORS.
;              C.  TURN OFF THE SOUND CHIP.
;              D.  DETERMINE IF A CARTRIDGE IS PLUGGED IN.
;                  IF SO, BRANCH TO THE CARTRIDGE PROGRAM
;                  ELSE, WAIT FOR CARTRIDGE.
;
FALSE      EQU      0
TRUE       EQU      1
; * VALUES FOR BOOLEAN FLAGS
;
; * BEGIN OF POWER_UP
POWER_UP:
; * IF CARTRIDGE = 55AAH THEN EXIT TO START_GAME (TEST)
        ld      hl, (CARTRIDGE)
        ld      a, l
        cp      055H
        jp      nz, NO_TEST_
        ld      a, h
        cp      0AAH
        jp      nz, NO_TEST_
        ld      hl, (START_GAME)
        jp      (hl)          ;INFO: index jump
; * ELSE
NO_TEST_:
; * TURN OFF SOUND CHIP
        call    TURN_OFF_SOUND
; * INITIALIZE RANDOM NUMBER GENERATOR
        ld      hl, 00033H
        ld      (RAND_NUM), hl
; * CLEAR CONTROLLER BUFFER AREAS
        call    CONTROLLER_INIT
; * DEFER_WRITES := FALSE
        ld      a, 000H
        ld      (DEFER_WRITES), a
; * MUX_SPRITES := FALSE
        ld      (MUX_SPRITES), a
; * EXIT TO DISPLAY LOGO AND TEST FOR CARTRIDGE
        jp      DISPLAY_LOGO
;
; COMMON PARAMETER PASSING ROUTINE
; To copy PASCAL functions parameters to CPU RAM (complex)
;
; * BEGIN OF PARAM_
PARAM_:
        pop     hl
        ex      (sp), hl
        push    hl
        ld      a, (bc)
        ld      l, a
        inc     bc
        ld      a, (bc)
        inc     bc
        ld      h, a

```

```

        ex      (sp),hl
        push    de
L00A3:  ld      e,(hl)
        inc     hl
        ld      d,(hl)
        inc     hl
        push    hl
        ld      a,e
        or      d
        jp      nz,L00B7
        pop     hl
        ld      e,(hl)
        inc     hl
        ld      d,(hl)
        inc     hl
        push    hl
        ex      de,hl
        ld      e,(hl)
        inc     hl
        ld      d,(hl)
L00B7:  inc     bc
        ld      a,(bc)
        rlca
        jp      nc,L00DA
        inc     bc
        pop     hl
        ex      (sp),hl
        ld      (hl),e
        inc     hl
        ld      (hl),d
        inc     hl
L00C4:  pop     de
        ex      (sp),hl
        dec     hl
        xor     a
        cp      h
        jp      nz,L00D0
        cp      l
        jp      z,L00D6
L00D0:  ex      (sp),hl
        push    hl
        ex      de,hl
        jp      L00A3
;
L00D6:  pop     hl
        ex      de,hl
        ex      (sp),hl
        jp      (hl)      ;INFO: index jump
;
L00DA:  pop     hl
        ex      (sp),hl
        push    hl
        rrca
        ld      h,a
        dec     bc
        ld      a,(bc)
        ld      l,a

```



```

        ex    (sp),hl
        inc   bc
        inc   bc
L00E5:   ld    a,(de)
        ld    (hl),a
        inc   hl
        inc   de
        ex    (sp),hl
        dec   hl
        xor   a
        cp    l
        jp    nz,L00F4
        cp    h
        jp    z,L00F8
L00F4:   ex    (sp),hl
        jp    L00E5
;
L00F8:   pop    hl
        jp    L00C4
;
; =====
; =                                SYSTEM RAM AREA                                =
; =====
;
SYSTEM_RAM_AREA      EQU    073BAH
; This is the RAM area dedicated to the basic OS needs. It includes the
; stack, various status variables, and all the variables used by OS
; routines.
;
STACK                EQU    SYSTEM_RAM_AREA-1
; This is the TOP of the STACK
;
PARAM_AREA           EQU    073BAH ; 9 bytes
; This is the common parameter passing area and the hole in the data
; area that is provided to make room for it.
; * To extract the parameters (PASCAL CALLS)
; * To initialize sound and timer data
; * ETC.
;
TIMER_LENGTH         EQU    073C0H
TEST_SIG_NUM         EQU    073C2H
;
VDP_MODE_WORD        EQU    073c3H ; 2 bytes
; The VDP mode word contains a copy of the data in the 1st two VDP
; registers. By examining this data, the OS and cartridge programs
; can make mode-dependent decisions about the sprite size or VRAM
; table arrangement. This word is maintained by the WRITE_REGISTER
; routine whenever the contents of registers 0 or 1 are changed.
;
; IMPORTANT NOTE *****
;
;          **** IT IS THE RESPONSIBILITY OF THE ****
;          **** CARTRIDGE PROGRAMMER TO MAKE      ****
;          **** SURE THAT NON-STANDARD USE OF     ****
;          **** THE VDP REGISTERS DOES NOT MAKE   ****
;          **** THE DATA IN THIS WORD INVALID    ****
;
VDP_STATUS_BYTE      EQU    073c5H
; The default handler for the NMI, which must read the VDP status
; register to clear the interrupt condition, places its contents

```

```

; here. This byte is the most accurate representation of the actual
; VDP status that is available to the cartridge programmer provided
; that the VDP interrupt is enabled on-chip
;
DEFER_WRITES          EQU    073C6H
; This is a boolean flag which is set to FALSE at power up time,
; should be set to true only if the cartridge programmer wishes
; to defer writes to VRAM. If this flag is true then the writer
; routine must be called regularly to perform deferred writes.
;
MUX_SPRITES           EQU    073C7H
; This boolean flag with default FALSE value should be set to TRUE if
; the cartridge programmer wishes one level of indirection to be
; inserted into sprite processing by having all sprites written to
; a local SPRITE_NAME_TABLE before being written to VRAM. This aids
; sprite multiplexing solution to the 5th sprite problem.
;
RAND_NUM              EQU    073C8H ; 2 bytes
; This is the shift register used by the random number generator.
; It is initialized at power-up.

```

## ***SOUND ROUTINE EQUATES***

```
;      Operating System Sound Routine EQUATES
;      FILE NAME: OSSR.EQU
;      *** Equates ***
;
; Dedicated Cartridge RAM locations
DEDAREA      EQU      07020H
; * DEDAREA is the start of the RAM area dedicated to sound routines
PTR_TO_LST_OF_SND_ADDRS      EQU      DEDAREA+0
PTR_TO_S_ON_0      EQU      DEDAREA+2
PTR_TO_S_ON_1      EQU      DEDAREA+4
PTR_TO_S_ON_2      EQU      DEDAREA+6
PTR_TO_S_ON_3      EQU      DEDAREA+8
SAVE_CTRL      EQU      DEDAREA+10
;
; Attenuation level codes
OFF      EQU      00FH      ; [no sound]
;
; Sound output port
SOUND_PORT      EQU      0FFH      ; data to sound chip thru this port
;
; Special byte 0 codes
INACTIVE      EQU      0FFH
SEFFECT      EQU      62      ; special sound effect code
ENDSDATA      EQU      0
;
; Offsets within an SxDATA song data area
CH      EQU      0      ; channel
SONGNO EQU      0      ; song number
NEXTNOTEPTR      EQU      1
FREQ      EQU      3      ; frequency
ATN      EQU      4      ; attenuation
CTRL      EQU      4
NLEN      EQU      5      ; noise
FPS      EQU      6      ; frequency sweep
FPSV      EQU      6
FSTEP      EQU      7
ALEN      EQU      8      ; attenuation sweep
ASTEP      EQU      8
APS      EQU      9
APSV      EQU      9
;
; Song end codes
CH0END      EQU      010H
CH1END      EQU      050H
CH2END      EQU      090H
CH3END      EQU      0D0H
CH0REP      EQU      018H
CH1REP      EQU      058H
CH2REP      EQU      098H
CH3REP      EQU      0D8H
;
; Channel numbers, B7-B6
CH0      EQU      000H
CH1      EQU      040H
CH2      EQU      080H
CH3      EQU      0C0H
```

## FREQ SWEEP RTN

```
; .IDENT FREQSWE          ;includes FREQ_SWEEP
;
; INCLUDE      OSSR_EQU:OS:0 ;equates
; #Globals
;     GLB      FREQ_SWEEP
; #Externals
;     GLB      DECLSN, DECMSN, MSNTOLSN, ADD816
; #Defines
FSTEP      EQU      007H
FPSV       EQU      006H
NLEN       EQU      005H
;*****
;*          FREQ_SWEEP          *
;*****
; .COMMENT }
; See User's Manual for description
; RETs Z SET: if note over
; RETs Z RESET: if sweep in progress or note not over
; }
FREQ_SWEEP:
; * if freq not swept, dec NLEN and RET [setting Z flag]
;     ld      a, (ix+FSTEP) ;check for no sweep code
;     cp      000H          ;set Z flag if FSTEP = 0
;     if      [psw,is,zero] ;note not to be swept
;         jr      nz, L20
;     ld      a, (ix+NLEN)   ;dec NLEN and
;     dec     a             ;SET Z flag if NLEN = 0
;     ret     z             ;leave if note over with Z flag SET
;     ld      (ix+NLEN), a   ;store decremented NLEN
;     ret                     ;RET with Z flag RESET [note not over]
; * sweep going, so decrement FPSV
L20:
;     push    ix            ;point HL to FPSV
;     pop     hl
;     ld      e, FPSV
;     ld      d, 000H
;     add     hl, de
;     call    DECLSN        ;decrement FPSV
;     if      [psw,is,zero] ;FPSV has timed out
;         jr      nz, L21
; * decrement NLEN and leave if sweep is over
;     call    MSNTOLSN      ;reload FPSV from FPS
;     dec     hl            ;point to NLEN [# steps in the sweep]
;     ld      a, (hl)       ;decrement NLEN and
;     dec     a             ;SET Z flag if NLEN = 0
;     ret     z             ;leave if sweep over with Z flag set
; * sweep not over, so add FSTEP to FREQ
;     ld      (hl), a       ;store decremented NLEN
;     dec     hl            ;point HL to FREQ
;     dec     hl
;     ld      a, (ix+007H)   ;A = FSTEP [two's complement step size]
;     call    ADD816        ;FREQ = FREQ + FSTEP
;     inc     hl            ;point HL to hi FREQ
;     res     2, (hl)       ;RESET B2 in hi FREQ in case add cased > 10 bit
;     or      0FFH          ;RESET Z flag, sweep not over yet
L21:
;     ret
```

## ATTENUATION SWEEP RTN

```

;      .IDENT ATNSWEE      ;includes ATN_SWEEP
;
; INCLUDE      OSSR_EQU:OS:0 ;equates
; #Globals
;      GLB      ATN_SWEEP
; #Externals
;      GLB      DECLSN,DECMSN,MSNTOLSN
; #Defines
APSV      EQU      009H
;*****
;*      ATN_SWEEP      *
;*****
; .COMMENT }
; See User's Manual for description
; RETs Z SET: if byte 8 is 0 [means sweep is over, or note was never swept]
; RETs Z RESET: if sweep in progress
; }
ATN_SWEEP:
;      * RET with Z SET if byte 8 = 00
;      ld      a,(ix+008H)      ;check byte 8 for no sweep code
;      cp      000H      ;Z is set if byte 8=0
;      ret     z      ;leave if Z set, sweep not going
;
;      * sweep going, so dec APSV
;      push    ix      ;point HL to APSV
;      pop     hl
;      ld      d,000H
;      ld      e,APSV
;      add     hl,de
;      call    DECLSN      ;dec APSV [LSN of byte 9]
;      if      [psw,is,zero] ;APSV has timed out
;      jr      nz,L22
;
;      * decrement ALEN to see if sweep over
;      call    MSNTOLSN      ;reload APSV from APS
;      dec     hl      ;point to ALEN [# of steps in the sweep]
;      call    DECLSN      ;dec ALEN [LSN byte 8]
;      jr      z,L23
;
;      * add ASTEP to ATN
;      ld      a,(hl)      ;MSN A = ASTEP
;      and     0F0H      ;mask LSN
;      ld      e,a      ;E = ASTEP | 0
;      dec     hl      ;point HL to ATN
;      dec     hl
;      dec     hl
;      ld      a,(hl)      ;MSN A = ATN
;      and     0F0H      ;A = ATN | 0
;      add     a,e      ;MSN A = [ASTEP + ATN] | 0
;      ld      e,a      ;Saved in E
;      ld      a,(hl)      ;A = ATN | freq or CTRL
;      and     00FH      ;mask old ATN A = 0 | freq or CTRL
;      or      e      ;OR in new ATN
;      ld      (hl),a      ;store updated value back into song data area
;      or      0FFH      ;RESET Z flag, sweep not over yet
;      jr      L22
;
;      ELSE
L23:      ld      (hl),000H      ;set byte 8 to 0 to indicate end sweep
L22:      ret

```

## UTILITY

```
;
; .IDENT UTIL          ;includes UPATNCTRL,UPFREQ,
;                      ;DECLSN,DECMSN,MSNTOLSN,ADD816,PT_IX_SxDATA,
;                      ;LEAVE_EFFECT,AREA_SONG_IS
;
; #Globals
;   GLB    UPATNCTRL,UPFREQ
;   GLB    DECLSN,DECMSN,MSNTOLSN
;   GLB    ADD816
;   GLB    PT_IX_SxDATA
;   GLB    LEAVE_EFFECT
;   GLB    AREA_SONG_IS
;
; INCLUDE    OSSR_EQU:OS:0 ;equates
;
; #Defines
; INACTIVE   EQU    0FFH
; FREQ       EQU    003H
; SOUND_PORT EQU    0FFH

;*****
;*          UPATNCTRL          *
;*****
; .COMMENT }
; Perform single byte update of the snd chip noise control register or any
; attenuation register. IX is passed pointing to byte 0 of a song data area, MSN
; register C = formatted channel attenuation code.
; }
UPATNCTRL:
    ld      a,(ix+004H)      ;MSN A=ATN, LSN may be CTRL data
    bit     4,c              ;test for ATN
;   if      [psw,is,nzero]   ;ATN is to be sent, move it to LSN
;       jr      z,L24
;       rrca
;       rrca
;       rrca
;       rrca
;
; L24:
;       and     00FH          ;mask MSN
;       or      c              ;a = formatted register# | ATN or CTRL
;       out     (SOUND_PORT),a ;output ATN or CTRL data
;       ret
;
; *****
;*          UPFREQ          *
; *****
; .COMMENT }
; Perform double byte update of a sound chip frequency register. IX is passed
; pointing to byte0 of a song data area, MSN register D = formatted channel
; frequency code.
; }
UPFREQ:
    ld      a,(ix+FREQ)      ;A =  F2  F3  F4  F5  F6  F7  F8  F9
    and     00FH              ;A =  0   0   0   0  F6  F7  F8  F9
    or      d                  ;A = FORMATTED REG# | F6  F7  F8  F9
    out     (SOUND_PORT),a    ;output 1st freq byte
    ld      a,(ix+FREQ)      ;A =  F2  F3  F4  F5  F6  F7  F8  F9
    and     0F0H              ;A =  F2  F3  F4  F5   0   0   0   0
    ld      d,a               ;save in D
    ld      a,(ix+FREQ+1)    ;LSN A = 0 0 F0 F1
```

```

    and    00FH          ;A =  0  0  0  0  0  0  F0  F1
    or     d             ;A =  F2 F3 F4 F5  0  0  F0  F1
    rrca                    ;swap nibbles
    rrca
    rrca
    rrca          ;A =  0  0  F0  F1  F2  F3  F4  F5
    out     (SOUND_PORT),a ;output 2nd [most significant] freq byte
    ret

;
;*****
;*          DECLSN          *
;*****
;.COMMENT }
;Without affecting the MSN, decrement the LSN of the byte pointed to by HL.
;HL remains the same.
;RET with Z flag set if dec LSN results in 0, reset otherwise.
;RET with C flag set if dec LSN results in -1, reset otherwise.
;}
DECLSN:
    ld     a,000H
    rrd                    ;A = 0 | LSN [HL]
    sub    001H           ;Z flag set if dec to 0, C flag if dec to -1
    push   af             ;save Z and C flag
    rld                    ;[HL] = old MSN | new LSN
    pop    af             ;restore Z and C flags, A = 0 | new LSN
    ret

;
;*****
;*          DECMSN          *
;*****
;.COMMENT }
;Without affecting the LSN, decrement the MSN of the byte pointed to by HL.
;HL remains the same.
;RET with Z flag set if dec MSN results in 0, reset otherwise.
;RET with C flag set if dec MSN results in -1, reset otherwise.
;}
DECMSN:
    ld     a,000H
    rld                    ;A = 0 | MSN [HL]
    sub    001H           ;Z flag set if dec to 0, C flag if dec to -1
    push   af             ;save Z and C flag
    rrd                    ;[HL] = new MSN | old LSN
    pop    af             ;restore Z and C flags, A = 0 | new MSN
    ret

;
;*****
;*          MSNTOLSN        *
;*****
;.COMMENT }
;Copy MSN of the byte pointed to by HL to the LSN of that byte.
;HL remains the same.
;}
MSNTOLSN:
    ld     a,(hl)         ;A = MSN | LSN to be changed
    and    0F0H           ;A = MSN | 0
    ld     b,a            ;save in B
    rrca                    ;swap nibbles
    rrca
    rrca          ;A = 0 | MSN
    or     b             ;A = MSN | MSN
    ld     (hl),a        ;[HL] = MSN | MSN
    ret

```

```

;
;*****
;*          ADD816          *
;*****
;.COMMENT }
;Adds 8 bit two's complement signed value passed in A to the 16 bit location
;pointed to by HL.
;}
ADD816:
    ld    b,000H          ;set B for positive value in A
    bit   7,a              ;if A is positive
    jr    z,POS            ;skip
    ld    b,0FFH          ;A is neg: extend sign bit thru B
POS:
    add   a,(hl)           ;do 8 bit add [and set Carry]
    ld    (hl),a           ;store result into LSN 16 bits number
    inc   hl               ;put MSB
    ld    a,(hl)           ;into A
    adc   a,b              ;A = MSB + Carry + B [B is 0 or FF]
    ld    (hl),a           ;store result into MSN
    dec   hl               ;re-point HL to LSB 16 bit number
    ret

;
;*****
;*          PT_IX_TO_SxDATA      *
;*****
;.COMMENT }
;SONGNO passed in B.
;Point IX to byte 0 in SONGNO's song data area.
;RET with both DE and IX pointing to SxDATA,
;HL pointing to MSB SxDATA entry in LST_OF_SND_ADDRS.
;}
PT_IX_TO_SxDATA:
; * IX & DE := addr of byte 0 in SONGNO's song data area,
; ; HL pointing to MSB SxDATA entry in LST_OF_SND_ADDRS.
;point HL to start LST_OF_SND_ADDRS
    ld    hl,(PTR_TO_LST_OF_SND_ADDRS)
    dec   hl               ;init HL for addition
    dec   hl
    ld    c,b              ;from 4*SONGNO in C
    ld    b,000H
    rlc   c
    rlc   c
    add   hl,bc            ;HL pts to SxDATA's entry in LST_OF_SND_ADDRS
    ld    e,(hl)           ;move addr SxDATA to IX thry DE
    inc   hl
    ld    d,(hl)
    push  de
    pop   ix
    ret

;
;*****
;*          LEAVE_EFFECT      *
;*****
;.COMMENT }
;LEAVE_EFFECT, called by a special sound effect routine when it's finished,
;restores the SONGNO of song to which the effect note belongs to B5-B0 of
;byte 0 in the effect's data area, and loads bytes 1 and 2 with the address of
;the next note in the song. The address of the 1 byte SONGNO (saved by the
;effect when 1st called) is passed in DE. The 2 byte address of the next note
;in the song, also saved by the effect, is passed in HL. IX is assumed to be
;pointing to byte 0 of the data area to which the song number is to be
;restored. Bits 7 and 6 of the saved SONGNO are ignored, and therefore may be

```



```

;used by the effect to store flag information during the course of the note.
;}
LEAVE_EFFECT:
    ld    (ix+001H),l    ;LSB NEXT_NOTE_PTR := LSB addr next note in song
    ld    (ix+002H),h    ;MSB NEXT_NOTE_PTR := MSB addr next note in song
    ld    a,(de)         ;A := x x SONGNO (i.e., the saved, original SONGNO)
    and    03FH           ;A := 0 0 SONGNO
    ld    b,a            ;Saved in B
    ld    a,(ix+000H)    ;A := CH# | 62 (all effect notes have SONGNO = 62)
    and    0C0H          ;A := CH# 0 0 0 0 0 0
    or     b             ;A := CH# | SONGNO
    ld    (ix+000H),a    ;restore song number
    ret

;
;*****
;*      AREA_SONG_IS      *
;*****
;.COMMENT }
;The address of byte 0 of a song data area is passed in IX.  The song # of
;the song using that area is returned in A [0FFH if inactive].  If a special
;effect was using that area, 62 is returned in A and HL is returned with the
;address of the special sound effect routine.
;}
AREA_SONG_IS:
    ld    a,(ix+000H)    ;A := CH# | SONGNO or 62, or A := FF
    cp    0FFH
    ret    z             ;leave if A = FF (area inactive)
    and    03FH          ;mask CH#
    cp    03EH
    ret    nz            ;leave with A = SONGNO (not a special effect)
    push  ix             ;point HL to byte 1
    pop   hl
    inc   hl
    ld    e,(hl)         ;save LSB effect addr in E
    inc   hl             ;HL to byte 2
    ld    d,(hl)         ;save MSB effect addr in D
    ex    de,hl          ;HL := addr special effect
    ret

```

## INIT SOUND

```

; .IDENT INITSOU      ;includes INIT_SOUND,ALL_OFF
;*****
;*      INIT_SOUND      *
;*****
;.COMMENT }
;see Users' Manual for description; includes ENTRY POINT ALL_OFF
;addr LST_OF_SND_ADDRS passed in HL
;n = # of song data areas to init, passed in B
;}
;
; #Globals
;      GLB      INIT_SOUND,ALL_OFF,DUMAREA
;
; INCLUDE      OSSR_EQU:OS:0;equates
;
; #Defines
OFF      EQU      OFFH
SR1ATN EQU      090H
SR2ATN EQU      0B0H
SR3ATN EQU      0D0H
SRNATN EQU      0F0H
SR1FRQ EQU      080H
SR2FRQ EQU      0A0H
SR3FRQ EQU      0C0H
SRNCTL EQU      0E0H

SOUND_PORT EQU      OFFH

INIT_SOUND_PAR:
    dw      00002H
    dw      00001H
    dw      00002H
;
INIT_SOUNDQ:
    ld      bc,INIT_SOUND_PAR
    ld      de,PARAM_AREA
    call    PARAM_
    ld      a,(PARAM_AREA)
    ld      b,a
    ld      hl,(PARAM_AREA+1)
INIT_SOUND:
;      * initialize PTR_TO_LST_OF_SND_ADDRS with value passed in HL
    ld      (PTR_TO_LST_OF_SND_ADDRS),hl
;      * store inactive code at byte 0 of each of the n data areas [B=n]
    inc     hl          ;pt HL to song 1 data area entry in LST_OF_SND_ADDRS
    inc     hl
    ld      e,(hl)      ;pt DE to byte 0 in first song data area
    inc     hl
    ld      d,(hl)
    ex      de,hl        ;pt HL to byte 0 in first song data area
    ld      e,00AH       ;set DE for 10 byte increment
    ld      d,000H
B1:
    ld      (hl),0FFH     ;deactivate area
    add     hl,de         ;pt HL to byte 0 next area (10 bytes away)
    djnz    B1           ;do this for n (passed in B) data areas
;      * store end of data area code (0) at 1st byte after last song data area
    ld      (hl),000H     ;store end of data area code in byte 0 data area n+1
;      * set the 4 channel data area pointers to a dummy, inactive data area

```

```

    ld    hl,DUMAREA    ;point HL to inactive byte below [after the RET]
    ld    (PTR_TO_S_ON_0),hl ;store addr DUMAREA at PTR_TO_S_ON_0
    ld    (PTR_TO_S_ON_1),hl ;store addr DUMAREA at PTR_TO_S_ON_1
    ld    (PTR_TO_S_ON_2),hl ;store addr DUMAREA at PTR_TO_S_ON_2
    ld    (PTR_TO_S_ON_3),hl ;store addr DUMAREA at PTR_TO_S_ON_3
;
* initialize SAVE_CTRL
    ld    a,0FFH        ;note: this is only time MSN SAVE_CTRL
                        ; will be non zero,
    ld    (SAVE_CTRL),a ;thus ensuring PLAY_SONGS will output
                        ; 1st real CTRL data

ALL_OFF:
;
* turn off all 4 sound generators
    ld    a,SR1ATN+OFF    ;form off code for tone generator 1
    out    (SOUND_PORT),a ;send it out
    ld    a,SR2ATN+OFF    ;form off code for tone generator 2
    out    (SOUND_PORT),a ;send it out
    ld    a,SR3ATN+OFF    ;form off code for tone generator 3
    out    (SOUND_PORT),a ;send it out
    ld    a,SRNATN+OFF    ;form off code for noise generator, N
    out    (SOUND_PORT),a ;send it out
    ret
;
DUMAREA:
    db    0FFH

```

## JUKEBOX

```

; .IDENT JUKEBOX ;includes JUKE_BOX
;*****
;* JUKE_BOX *
;*****
;.COMMENT }
;see Users' Manual for description
;SONGNO passed in B
;}
;
; #Globals
; GLB JUKE_BOX
; GLB JUKE_BOXQ
;
; #Externals
; EXT PT_IX_TO_SxDATA,LOAD_NEXT_NOTE,UP_CH_DATA_PTRS
;
; INCLUDE OSSR_EQU:OS:0 ;equates
;

JUKE_BOX_PAR:
    dw 00001H
    dw 00001H
;
JUKE_BOXQ:
    ld bc,JUKE_BOX_PAR
    ld de,PARAM_AREA
    call PARAM_
    ld a,(PARAM_AREA)
    ld b,a
JUKE_BOX:
; * RET if song already in progress
    push bc ;save SONGNO on stack
    call PT_IX_TO_SxDATA ;point IX to SONGNO's song data area
    ld a,(ix+000H) ;A := CH# [if any] | SONGNO [if any]
    and 03FH ;A := 0 0 SONGNO
    pop bc ;B := SONGNO
    cp b ;test if already in progress
    ret z ;if so, leave
; * load 1st note and set NEXT_NOTE_PTR [thru LOAD_NEXT_NOTE]
    ld (ix+000H),b ;store SONGNO in byte 0
    dec hl ;HL left by PT_IX_TO_SxDATA
    ; pointing to MSB SxDATA
    dec hl ;-entry in LST_OF_SND_ADDRS; point HL to note list
    ld d,(hl) ;-starting addr entry in LST_OF_SND_ADDRS
    ; and save this
    dec hl ;-addr in DE
    ld e,(hl) ;DE now has the initial value for NEXT_NOTE_PTR
    ld (ix+001H),e ;set NEXT_NOTE_PTR for 1st note in song
    ld (ix+002H),d
    call LOAD_NEXT_NOTE ;load note, byte 0 := CH#|SONGNO,
    ; set new NEXT_NOTE_PTR
    call UP_CH_DATA_PTRS ;new song, so update channel data ptrs
    ret

```

## SOUND MANAGER

```
; .IDENT SNDMAN;includes TONE_OUT
;*****
;*      SONG_MANAGER      *
;*****
;.COMMENT }
;see Users' Manual for description
;}
;
; #Globals
;     GLB      SND_MANAGER
;     GLB      UP_CH_DATA_PTRS
;     GLB      PROCESS_DATA_AREA
;     GLB      EFXOVER
;
; #Externals
;     EXT      PT_IX_TO_SxDATA,AREA_SONG_IS
;     EXT      DUMAREA
;     EXT      LOAD_NEXT_NOTE,ATN_SWEEP,FREQ_SWEEP
;
; INCLUDE      OSSR_EQU:OS:0;equates
ENDSDATA      EQU      000H
INACTIVE      EQU      0FFH

SND_MANAGER:
;     * IX := addr of song #1 data area [S1DATA]
;     ld      b,001H      ;pt IX to byte 0 song data area for song# 1
;     call    PT_IX_TO_SxDATA
;     LOOP until end of song data areas
L1:
;     ld      a,ENDSDATA      ;check for end of song data areas
;     cp      (ix+000H)      ;set Z flag if negative
;     ret     z              ;leave [Z set],
; if all data areas have been processed
;     * process active song data areas
;     call    PROCESS_DATA_AREA ;update counters of call effect; get next note
;     * point IX to byte 0 next song data area
;     ld      e,00AH
;     ld      d,000H
;     add     ix,de
;     jr      L1      ; repeat loop
;*****
;*      UP_CH_DATA_PTRS      *
;*****
;.COMMENT }
;For each active data area, starting with S1DATA and proceeding in order, load
;the associated channel data area pointer [PTR_TO_S_ON_x] with the address of
;byte 0. This routine is called by JUKE_BOX, when a song starts and
;PROCESS_DATA_AREA when the channel using a data area has changed as a result
;of calling LOAD_NEXT_NOTE [this happens when a song finishes and when it
;switches back and forth between noise and tone notes].
;}

UP_CH_DATA_PTRS:
;     push    ix      ;save current IX
;     ld      hl,DUMAREA ;set all 4 ch data ptrs to dummy inactive area
;     ld      (PTR_TO_S_ON_0),hl
;     ld      (PTR_TO_S_ON_1),hl
;     ld      (PTR_TO_S_ON_2),hl
;     ld      (PTR_TO_S_ON_3),hl
;     ld      b,001H
```

```

        call    PT_IX_TO_SxDATA
; LOOP until end of song data areas
L2:
        ld      a,(ix+000H)
        cp      ENDSDATA          ;check for end of song data areas
        jr      z,DONE_SNDMAN      ;leave loop if all data areas checked
; * if area active, set appropriate channel data area pointer
        cp      INACTIVE          ;check for inactive data area:
                                   ; don't up date ptr if so
;
        if      [PSW,IS,ZERO] ;area is active: update channel data ptrs
        jr      z,L9
        ld      a,(ix+000H)        ;get CH# in A
        and     0C0H              ;B7 - B6 in A = CH#
        rlca                    ;form CH# * 2 in A,i.e., the offset from
        rlca                    ;PTR_TO_S_ON0 of channel data area pointer
        rlca                    ;that points to channel CH#
        ld      e,a               ;add offset to addr of PTR_TO_C_ON_0
        ld      d,000H
        ld      hl,PTR_TO_S_ON_0
        add     hl,de              ;HL points to proper channel data area pointer
        push    ix                ;store this song data area's byte 0 addr there
        pop     de
        ld      (hl),e
        inc     hl
        ld      (hl),d
; * point IX to byte 0 next song data area
L9:
        ld      e,00AH
        ld      d,000H
        add     ix,de
        jr      L2                ;repeat loop
;
DONE_SNDMAN:
        pop     ix                ;restore IX
        ret
;
;*****
;*      UP_CH_DATA_PTRS          *
;*****
; .COMMENT }
; See Users' Manual for description
; Terminology: SFX = address of sound effect routine
; }
PROCESS_DATA_AREA:
        call    AREA_SONG_IS ;return area's SONGNO in A [and addr SFX in HL]
        cp      INACTIVE          ;test for inactive code
        ret     z                 ;RET, no processing if area inactive
; * if special effect, call it to process the data area
        cp      03EH              ;test for special sound effect
        jr      nz,L10
        ld      e,007H            ;pt HL to SFX+7, starting adr of the effect's code
        ld      d,000H
        add     hl,de
        jp      (hl)              ;do 1 pass thru effect, RET from effect
;
; * else process a non-effect note
L10:
        call    ATN_SWEEP          ;process atn sweep data, if any
        call    FREQ_SWEEP         ;proc frq sweep data, if any, & note dura timers
;
        if [psw,is,zero]          ;note is over
        jr      nz,L12
EFXOVER:
        ld      a,(ix+000H)        ;A := CH# | SONGNO this note

```

```

        push    af                ;save on stack
        call    LOAD_NEXT_NOTE    ;load data for next note
        pop     bc                ;B := CH# | SONGNO previous note
        ld      a,(ix+000H)        ;A := CH# | SONGNO new note [may be inactive]
        cp      b                ;check against new note's CH# | SONGNO
;       if      [psw,is,nzero]     ;change to/from tone/efx/noise
        jr      z,L12
        call    UP_CH_DATA_PTRS    ;to maintain data area priority system
L12:
        ret

```

## PLAY SONG

```

; .IDENT PLAYSON ;includes TONE_OUT
;*****
;* PLAY_SONGS_ *
;*****
;.COMMENT }
;see Users' Manual for description
;SFX refers to the beginning address of a special sound effect routine
;}
;
; #Globals
; GLB PLAY_SONGS_,TONE_OUT
;
; #Externals
; EXT UPATNCTRL,UPFREQ
;
; INCLUDE OSSR_EQU:OS:0 ;equates
;
; #Defines
OFF EQU 00FH
SR1ATN EQU 090H
SR2ATN EQU 0B0H
SR3ATN EQU 0D0H
SRNATN EQU 0F0H
SR1FRQ EQU 080H
SR2FRQ EQU 0A0H
SR3FRQ EQU 0C0H
SRNCTL EQU 0E0H

SOUND_PORT EQU 0FFH

PLAY_SONGS_:
; * output CH1 attenuation and frequency
ld a,SR1ATN+OFF ;format CH1 OFF byte into A
ld c,SR1ATN ;format MSN C for CH1 attenuation
ld d,SR1FRQ ;format MSN D for CH1 frequency
ld ix,(PTR_TO_S_ON_1) ;point IX to byte 0 data area
; of song for CH1
call TONE_OUT
; * output CH2 attenuation and frequency
ld a,SR2ATN+OFF ;format CH2 OFF byte into A
ld c,SR2ATN ;format MSN C for CH2 attenuation
ld d,SR2FRQ ;format MSN D for CH2 frequency
ld ix,(PTR_TO_S_ON_2) ;point IX to byte 0 data area
; of song for CH2
call TONE_OUT
; * output CH3 attenuation and frequency
ld a,SR3ATN+OFF ;format CH3 OFF byte into A
ld c,SR3ATN ;format MSN C for CH3 attenuation
ld d,SR3FRQ ;format MSN D for CH3 frequency
ld ix,(PTR_TO_S_ON_3) ;point IX to byte 0 data area
; of song for CH3
call TONE_OUT
; * output CH0 [noise] ATN [and CTRL, if different from last time]
ld a,SRNATN+OFF ;format CH0 OFF byte into A
ld c,SRNATN ;format MSN C for CH0 attenuation
ld ix,(PTR_TO_S_ON_0) ;point IX to byte 0 data area
; of song for CH0
ld e,(ix+000H) ;look for inactive code 0FFH
inc e ;this sets Z flag if E = 0FFH

```



```

;      if      [psw,is,zero]      ; song data area is inactive
;      jr      nz,L5
;      out     (SOUND_PORT),a      ;turn off CH0
;      jr      L6
;      ELSE
L5:      call    UPATNCTRL          ;send out current ATN
;      ld      a,(ix+004H)          ;LSN A = current CTRL data
;      and     00FH                ;mask MSN
;      ld      hl,SAVE_CTRL        ;point to last CTRL data sent
;      cp      (hl)                ;compare
;      if      [psw,is,nzero]      ;CTRL has changed
;      jr      z,L6
;      ld      (hl),a              ;SAVE_CTRL = new CTRL data
;      ld      c,SRNCTRL           ;send new CTRL data
;      call    UPATNCTRL
L6:      ret
;
TONE_OUT:
;      ld      e,(ix+000H)          ;look for inactive code, 0FFH
;      inc     e                    ;this sets Z flag if E = 0FFH
;      if      [psw,is,zero]      ;song data area is inactive
;      jr      nz,L7
;      out     (SOUND_PORT),a      ;turn off CHx
;      jr      L8
;      ELSE
;      ;send out current ATN and FREQ
L7:      call    UPATNCTRL          ;send out attenuation
;      call    UPFREQ              ;send out frequency
L8:      ret

```

## LOAD NEXT NOTE

```
; .IDENT LOADNEX          ;includes LOAD_NEXT_NOTE
;*****
;*      LOAD_NEXT_NOTE      *
;*****
;.COMMENT }
;see Users' Manual for description
;SFX refers to the beginning address of a special sound effect routine
;}
;
; #Globals
;     GLB      LOAD_NEXT_NOTE
;     GLB      REST,ENDREP,ENDNOREP,EFFECT,TYPE0,TYPE1,TYPE2,TYPE3
;     GLB      MODB0,DE_TO_DEST,PASS1
;
; #Externals
;     EXT      JUKE_BOX
;
; INCLUDE      OSSR_EQU:OS:0 ;equates
;
; #Defines
ATN          EQU      4
NLEN         EQU      5
FSTEP        EQU      7
ASTEP        EQU      8
INACTIVE     EQU      0FFH
```

### LOAD\_NEXT\_NOTE:

```
; * deactivate area, save SONGNO on stack
ld      a,(ix+000H)          ;A := byte 0
and      03FH                ;mask CH#, if any
push     af                  ;save SONGNO on stack
ld      (ix+000H), INACTIVE ;deactivate area
; A := header new note
ld      l,(ix+001H)          ;HL := addr new note in ROM
ld      h,(ix+002H)
ld      a,(hl)               ;A := header new note
; * save header of new note in song on stack
;   and load its data CASE note type
ld      b,a                  ;save header new not in B
;
- test for rest
bit      5,a                  ;test for rest
;
if      [psw,is,nzero]       ;note is rest
jr      z,L13
;
--CASE-- rest
REST:
push     bc                  ;save header on stack
and      01FH                ;mask all but duration bits
inc      hl                  ;HL = addr of the header of the note after this note
ld      (ix+001H),l          ;store in NEXT_NOTE_PTR
ld      (ix+002H),h
; move this note's data and fill in bytes where necessary
ld      (ix+ATN),0F0H ;set stn off
ld      (ix+NLEN),a          ;NLEN := 5 bit duration
ld      (ix+FSTEP),000H      ;indicate freq not to be swept
ld      (ix+ASTEP),000H      ;indicate atn not to be swept
jp      MODB0
;
; - test for end of song
L13:
```

```

        bit    4,a                ;test for end
;       if     [psw,is,nzero]     ;end of song
        jr     z,L14
        bit    3,a                ;test for repeat
;       if     [PSW,is,nzero]     ;end of song
        jr     z,ENDNOREP
;       --CASE-- end song, repeat
ENDREP:
        pop     bc                ;B := SONGNO
        call    JUKE_BOX          ;to reload 1st note of this song
        ret                     ;to PROCESS_DATA_AREA, don't save header
;
;       --CASE-- end song, no repeat
ENDNOREP:
        ld      a, INACTIVE
        push    af                ;save inactive code to end song
        jp      MODB0            ;to load byte 0
;
;       - test for special sound effect
L14:
        and     03CH              ;mask irrelevant bits
        cp      004H              ;test for B5 - B2 = 0001
;       if     [psw,is,zero] ;note is a special effect
        jr     nz,L15
;       --CASE-- special effect
EFFECT:
        pop     iy                ;IY := SONGNO
        push    iy                ;put SONGNO back on stack
        push    bc                ;save header on stack; NEXT_NOTE_PTR := SFX, DE := SFX
        inc     hl                ;-pt HL to next byte [LSB addr SFX]
        ld      e,(hl) ; -E := LSB SFX
        ld      (ix+001H),e       ;-put LSB of SFX in byte 1 of SxDATA [NEXT_NOTE_PTR]
        inc     hl                ;-pt HL to NSB SFX
        ld      d,(hl) ; -D := NSB SFX
        ld      (ix+002H),d       ;-put NSB SFX in byte 2 of SxDATA
        inc     hl                ;point HL to next note [after this new note]
        push    iy                ;A := SONGNO
        pop     af
        push    de                ;PASS1 on the stack
        pop     iy
        ld      de,PASS1          ;create "CALL [IY]" with RET to PASS1 by storing
        push    de                ;PASS1 on stack
        jp      (iy)             ;1st 7 bytes SFX will save addr next note & SONGNO
;
PASS1:
        ld      d,000H            ; in same fashion, create a "CALL (IY+7)"
        ld      e,007H            ; to allow SFX to load initial values
        add     iy,de
        ld      de,MODB0          ;RET to MODB0
        push    de
        jp      (iy)             ;INFO: index jump
;       - if here, note is type 0 - 3
L15:
        push    bc                ; save header on stack
        ld      a,b                ; A := fresh copy header
        and     003H              ; mask all but type number
        cp      000H              ; test for type 0
;       if     [psw,is,zero] ; note is type 0: fixed freq and atn
        jr     nz,L16
;       --CASE-- note type 0
;       * set up NEXT_NOTE_PTR
TYPE0:
        inc     hl                ; next note [after this new note] is 4 bytes away,

```

```

    inc    hl                      ; point HL to it
    inc    hl
    inc    hl
    ld     (ix+001H),l             ; put addr in NEXT_NOTE_PTR
    ld     (ix+002H),h
    ; move new note data and fill in bytes where necessary
    dec    hl                      ; point HL back to 1st ROM data to move, NLEN
    ld     de,00005H              ; point DE to destination: bytes 5,4, and 3
    call   DE_TO_DEST
    ld     bc,00003H              ; move 3 bytes
    lddr
    ld     (ix+FSTEP),000H         ; set for no freq sweep
    ld     (ix+ASTEP),000H        ; set for no atn sweep
    jr     MODB0
;
L16:
    cp     001H                   ; test for type 1
    ; if [psw,is,zero]; note is type 1: swept freq, fixed attenuation
    jr     nz,L17
    ; --CASE-- not type 1
    ; * set up NEXT_NOTE_PTR
TYPE1:
    ld     e,006H                 ; note after this note is 6 bytes away,
    ld     d,000H                 ; pt HL to it
    add    hl,de
    ld     (ix+001H),l            ; store in NEXT_NOTE_PTR
    ld     (ix+002H),h
    ; move new note data and fill in bytes where necessary
    dec    hl                      ; point HL back to 1st ROM data to move, FSTEP
    inc    e                      ; E:=7; point DE to destination: bytes 7 - 3
    call   DE_TO_DEST
    ld     bc,00005H              ; move 5 bytes
    lddr
    ld     (ix+ASTEP),000H        ; set for no atn sweep
    jr     MODB0
;
L17:
    cp     002H                   ; test for type 2
    ; if [psw,is,zero]; note is type 2: fixed freq, swept attenuation
    jr     nz,TYPE3
    ; --CASE-- note type 2
    ; * set up NEXT_NOTE_PTR
TYPE2:
    ld     e,006H                 ; pt HL to note after this note
    ; since it's 6 bytes away,
    ld     d,000H                 ; pt HL to it by adding 6
    add    hl,de
    pop    af                     ; A := header this note [CH# | SONGNO]
    push   af                     ; put back on stack
    and    0C0H                   ; mask SONGNO, leaving CH#
    ; if [psw,is,zero]
    ; This is a noise note,
    ; which is only 5 ROM bytes long
    jr     nz,L18
    dec    hl                     ; so move HL back 1 byte
L18:
    ld     (ix+001H),l            ; put addr in NEXT_NOTE_PTR
    ld     (ix+002H),h
    ; move new note data and fill in bytes where necessary
    dec    hl                      ; point HL back to 1st ROM data to move, APS
    ld     e,009H                 ; point DE to destination: bytes 9,8,5 - 3
    call   DE_TO_DEST
    ld     bc,00002H              ; move 2 bytes

```

```

        lddr                ; when done, DE points to FSTEP, HL to ROM
NLEN:
        ld      a,000H
        ld      (de),a      ; FSTEP := 0 for no freq sweep
        dec     de          ; pt DE to RAM NLEN
        dec     de
        ld      c,003H      ; move last 3 ROM bytes
                           ; if this is a noise note, garbage
        lddr                ; will be loaded into byte 3, but's that's OK
        jr      MODB0
;
TYPE3:
        ld      e,008H      ; note after this note is 8 bytes away
        ld      d,000H      ; pt HL to it
        add     hl,de
        ld      (ix+001H),l  ; put addr in NEXT_NOTE_PTR
        ld      (ix+002H),h
        ; move new note data and fill in bytes where necessary
        dec     hl          ; Point HL back to 1st ROM data to move, APS
        push    ix          ; Point DE to destination: bytes 9-3
        pop     iy          ; IY := Addr byte 0 [and DE = 6]
        ld      e,009H      ; DE := 9
        add     iy,de        ; IY := Addr byte 9 [APS]
        push    iy
        pop     de          ; DE := addr APS
        ld      bc,00007H    ; move 7 bytes
        lddr
MODB0:
        push    ix          ;pt HL to byte 0
        pop     hl
        pop     af          ; A := Header new note
        pop     bc          ; B := SONGNO
        cp      0FFH        ; Test for inactive [song over, as detected
above]
        ret     z
        ld      d,a          ; Save header in D
        and     03FH        ; Rid channel bits
        cp      004H        ; Special effect
        jr      nz,L20_LOAD_NEX
        ld      b,03EH
L20_LOAD_NEX:
        ld      a,d          ; Restore A to header
        and     0C0H        ; A := CH# 0 0 0 0 0 0
        or      b            ; A := new CH# | SONGNO
        ld      (hl),a      ; Store back in byte 0
L19:
        ret
;
DE_TO_DEST:
;DE passed = offset from byte 0, RETed with address byte offset
        push    ix
        pop     iy          ; IY := Addr byte 0 (and DE = offset)
        add     iy,de        ; IY := Addr byte 0 + offset
        push    iy
        pop     de          ; DE := Addr of destination byte in SxDATA
        ret

```

## ACTIVATE

```
; .IDENT ACTIVATE
; .ZOP
; .EPOP
; .COMMENT }
;***** ACTIVATE *****
;
;                                     4/22/82
;                                     13:50:00
;
; The following changes/revisions were made:
;
; 1. Eliminate code placing OLD_SCREEN address in status area
; 2. Init X_PAT POS in OLD_SCREEN when in VRAM as well as when in CPU RAM
; 3. Use VDP_MODE_WORD to test graphics mode
; 4. Add code to expand one color generator byte to 8
; 5. Added C_BUFF defs 8 for color expanding code
; 6. Fix color gen move in mode 1 (5/02)
; 7. Use CONTROLER_MAP for buffer area
;
;
; ACTIVATE is used to initialize the RAM status area for the passed
; object and move its pattern and color generators to the PATTERN and
; COLOR generator tables in VRAM_ The second function is enabled or
; disabled by setting or resetting the carry flag in the PSW_ this is
; necessary to prevent sending the same graphics data to VRAM more than
; once when creating identical objects_ The calling sequence for
; activating an object is as follows:
;
; LD      HL,OBJ_n      ; ->OBJ to activate
; SCF      ; Signal MV to VRAM
; CALL    ACTIVATE
;
; OR
;
; LD      HL,OBJ_n      ; ->OBJ to activate
; OR      A             ; Don't MV to VRAM
; CALL    ACTIVATE
;
; #External
; EXT     PUT_VRAM_,VRAM_WRITE,VDP_MODE_WORD
; EXT     WORK_BUFFER
;
; #Global
; GLB     ACTIVATEQ, ACTIVATE_
;
; Register usage: Following will be changed by activate, additional
; may be changed by called SUBR.
; AF,HL,DE,BC,IY
;
; PROCEDURE ACTIVATEQ[VAR OBJ:OBJECT;MOVE:BOOLEAN];
;
; ACTIVATEQ is the Pascal entry point to ACTIVATE
;
; EXT     PARAM_
; The Pascal parameter passing procedure
; #Common
; PRM_DATA:      DEFS 3      ; Moved to OS
; This is the common parameter passing area

ACTIVATE_P:
```

```

        dw      00002H
        dw      0FFFEH
        dw      00001H
;
ACTIVATEQ:
        ld      bc,ACTIVATE_P
        ld      de,PARAM_AREA
        call    PARAM_
        ld      hl,(PARAM_AREA)
        ld      e,(hl)
        inc     hl
        ld      d,(hl)
        ex      de,hl
        ld      a,(PARAM_AREA+2)
        cp      000H
        jr      z,NTZZZ_
        scf
        jr      TZZZ_
;
NTZZZ_:
        or      a
TZZZ_:
ACTIVATE_:
; SUP pointers etc_common to all subcases
; HL -> OBJ DEF CPU ROM
; C FLG = SUP VRAM FLG
        ld      e,(hl)          ;->OBJ GEN CPU ROM
        inc     hl
        ld      d,(hl)
        inc     hl
        ld      c,(hl)          ;->OBJ CPU RAM
        inc     hl
        ld      b,(hl)
        inc     hl
        ld      a,000H          ;ZERO FRAME
        ld      (bc),a
        ld      a,(de)          ;GET OBJ_TYPE
        push    af              ;SV OBJ_TYPE & FLG
        and     00FH            ;GET OBJ_TYPE NUM
        jp      z,ACT_SEMI      ;TYPE=0
                                ; SEMI-MOBILE

        dec     a
        jp      z,ACT_MOBILE    ;TYPE=1
                                ; MOBILE

        dec     a
        jp      z,ACT_0SPRT     ;TYPE=2
                                ; 0SPRITE

        dec     a
        jp      z,ACT_1SPRT     ;TYPE=3
                                ; 1SPRITE

        dec     a
        jr      z,ACT_CMPLX     ;TYPE=4
                                ; COMPLEX

        pop     af              ;SUBCASE ELSE
        ret
;ON ENTRY TO SUBCASE
; STACK=OBJ_TYPE & SUP VRAM FLG
; HL->OBJ_n+4
; DE->OBJ_GRAPHICS+0
; BC->OBJ_STATUS+0
; A=0
;
ACT_CMPLX:

```

```

; SUBCASE Complex
    ld    a,(de)                ;GET COMP_CNT
    rra
    rra
    rra
    rra
    and    00FH
    ld    b,a                  ;SET CNTR
    ld    e,(hl)                ;DE->comp ptrs list
    inc    hl
    ld    d,(hl)
    inc    hl
    or     a                    ;? EMPTY
    jr     z,CMPLX9
CMPLX4:
    pop    af                  ;Sup call, comp obj
    push   af
    push   hl
    push   bc
    ex     de,hl
    call   ACTIVATE_
    pop    bc                  ;Restore pntrs
    pop    hl
    ld     e,(hl)
    inc    hl
    ld     d,(hl)
    inc    hl
    djnz   CMPLX4              ;? More, reloop
CMPLX9:
    pop    af                  ;Clear stack for rtn
    ret                                ;Technacally should jmp to rtn
;
ACT_SEMI:
; SUBCASE Semi_Mobile
    call   INIT_XP_OS          ;X_PAT_POS := 80H
    ld     a,(de)              ;A := FIRST_GEN_NAME
    ld     l,a
    inc    de
    ld     a,(de)              ;A := NUMGEN
    add    a,l
    ld     (iy+005H),a         ;NEXT_GEN := FIRST_GEN_NAME + NUMGEN
    ld     h,000H              ;HL=FIRST_GEN_NAME
;At this point:
;   STACK=OBJ_TYPE & SUP VRAM FLG
;   HL=FIRST_GEN_NAME
;   DE->NUMGEN
;   BC:FREE
;SUP FOR VRAM INIT
    pop    af                  ;If sup VRAM flg on
    jr     nc,SEMI_EXIT
    push   af
    ld     a,(VDP_MODE_WORD)   ;See which graphics mode
    bit    1,a                 ;If GR II mode
    jr     z,SEMI_GRI          ;-, GO GRI
    ex     de,hl               ;DE=FIRST_GEN_NAME
    ld     b,h                 ;SV->NUMGEN
    ld     c,l
    ld     l,(hl)              ;CALC source offset
    ld     h,000H
    push   hl
    add    hl,hl
    add    hl,hl
    add    hl,hl

```



```

        push    hl
        inc     bc                      ;HL->source buffer
        ld      a,(bc)
        ld      l,a
        inc     bc
        ld      a,(bc)
        ld      h,a
        pop     bc
        pop     iy
        pop     af
;At this point:
;   HL->SOURCE BUFFER, PTRN GNRTRS
;   DE=INDEX TO START OF VRAM ENTRIES
;   IY=NUMBER OF ITEMS TO READ FROM VRAM
;   BC=OFFSET TO COLOR SOURCE BUFFER 2
;   AF=OBJ_TYPE [& SUP VRAM FLG, UNNEEDED]
;Fill as needed top, mid, and bot PTRN_GNRTRS & DITTO for COLOR_GNRTRS
        bit     7,a                    ;If bit 7 OBJ_TYPE ON (top)
        jr      z,SEMI_MID             ;-, GO HNDL MID
        call    SUP_GEN_CLR
SEMI_MID:
        call    SUP_UPDATE
        bit     6,a                    ;If bit 6 OBJ_TYPE ON (mid)
        jr      z,SEMI_BOT
        call    SUP_GEN_CLR
SEMI_BOT:
        call    SUP_UPDATE
        bit     5,a                    ;If bit 5 OBJ_TYPE ON (bot)
        jr      z,SEMI_EXIT
        call    SUP_GEN_CLR
SEMI_EXIT:
        ret
;
SEMI_GRI:
        ex      de,hl                 ;HL->NUMGEN
        ld      c,(hl)                 ;IY=NUMGEN
        ld      b,000H
        push    bc
        pop     iy
        inc     hl                     ;HL->PTRN_GNRTRS
        ld      a,(hl)
        inc     hl
        ld      h,(hl)
        ld      l,a
        push    hl                     ;SAVE FOR RESTORE
        push    bc
        push    de
        push    iy
        ld      a,003H                 ;SIGNAL PTRN GEN FILL
        call    PUT_VRAM_
        pop     bc                     ;BC:=NUMGEN
        pop     hl                     ;HL:=FIRST_GEN_NAME
        ld      e,l
        ld      d,h                     ;DE:=HL
        add     hl,bc                   ;HL:=FIRST_GEN_NAME+NUMGEN
        dec     hl
        srl     h
        rr      l
        srl     h
        rr      l
        srl     h
        rr      l                     ;HL:=(FIRST_GEN_NAME+NUMGEN-1)/8
        sra     e

```

```

sra    e
sra    e                ;DE:=FIRST_GEN_NAME/8
or     a                ;Clear carry
sbc    hl,de
inc    hl                ;HL:=(F_G_N+NMGN-1)/8-F_G_N/8+1=NUMBER_COLR_GENS
push   hl
pop    iy
pop    hl                ;Restore reg
add    hl,hl            ;Step over PTRN_GNRTRS
add    hl,hl
add    hl,hl
pop    bc
add    hl,bc            ;HL->COLOR_GNRTR_SOURCE
ld     a,004H          ;SIGNAL_PTRN_COLOR_TBL
call   PUT_VRAM_
pop    af                ;FIX_STACK
ret

;Internal routine to initialize X_PAT_POS in OLD_SCREEN
INIT_XP_OS:
push   bc
pop    iy                ;IY->STATUS
push   de                ;SAVE->GRAPHICS
ld     e,(hl)            ;DE:=OLD_SCREEN_ADDRESS
inc    hl
ld     d,(hl)
bit    7,d                ;? OLD_SCRN_IN_CPU_ROM
jr     nz,SM_BY_OLD
ld     a,d                ;OLD_SCREEN_IN_VRAM?
cp     070H
jr     c,OS_IN_VRAM
ld     a,080H            ;INIT_X_PAT_POS = 80H
ld     (de),a
jr     SM_BY_OLD

;
INIT_80:
db     080h
OS_IN_VRAM:
ld     hl,INIT_80
ld     bc,00001H          ;ONE_BYTE_TO_MOVE_TO_VRAM
call   VRAM_WRITE
SM_BY_OLD:
pop    de                ;DE->GRAPHICS
inc    de                ;DE->FIRST_GEN_NAME
ret

;
;Internat rtn to setup Ptrn Gen VRAM & Color Gen VRAM
SUP_GEN_CLR:
push   af                ;SAVE_FOR_RESTORE
push   bc
push   iy
push   de
push   hl
ld     a,003H            ;Signal_PTRN_gen_fill
call   PUT_VRAM_
pop    hl                ;Restore
pop    de
pop    iy
pop    bc
pop    af
push   af
push   bc                ;Save_for_retor
push   iy
push   de

```

```

        push    hl
        bit     4,a                      ;How many color gen bytes?
        jr      nz,ONE_BYTE
        add     hl,bc                    ;HL->Color gen source
        ld      a,004H                  ;Signal PTRN color fill
        call    PUT_VRAM_
O_B_RET:
        pop     hl
        pop     de
        pop     iy
        pop     bc
        pop     af
        ret
; For each item to send, duplicate the color byte 8 times [in C_BUFF]
; then send this generator to VRAM color table indexed by DE
ONE_BYTE:
        add     hl,bc                    ;HL->Color byte
        ld      c,l
        ld      b,h                      ;BC->Color byte
        push    iy
        pop     hl                      ;HL = Item count
NEXT_COLOR:
        push    hl                      ;Save counter
        ld      a,(bc)                  ;Get color byte
        push    bc                      ;Save pointer to color
        ld      bc,00008H                ;Create 8 duplicates
        ld      hl,(WORK_BUFFER)
        add     hl,bc                    ;Place then here, starting at end of buffer
        ld      b,008H
DUPLI:
        dec     hl
        ld      (hl),a
        djnz    DUPLI
        push    de                      ;Save index into tables
        ld      iy,00001H                ;1 item to send
        ld      a,004H                  ;Color table code
        call    PUT_VRAM_
        pop     de                      ;Get index back
        pop     bc                      ;Pointer to color byte
        inc     de                      ;Increment index
        inc     bc                      ;Increment color pointer
        pop     hl                      ;Get item counter
        dec     hl
        ld      a,h
        or      l
        jr      nz,NEXT_COLOR
        jr      O_B_RET
;Internal RTN to update to next VRAM index screen area
SUP_UPDATE:
        push    bc
        ld      bc,00100H
        ex      de,hl
        add     hl,bc
        ex      de,hl
        pop     bc
        ret
;
ACT_MOBILE:
; SUBCASE Mobile
        call    INIT_XP_OS              ;X_PAT_POS := 80H
; Insert new_generator address in object CPU RAM
        inc     de
        ld      a,(de)

```

```

        ld      (iy+005H),a
        inc     de
        ld      a,(de)
        ld      (iy+006H),a      ;Init NEW_GEN in status
        pop     af
        ret

;
ACT_0SPRT:
; SUBCASE Sprite size 0
ACT_1SPRT:
; SUBCASE Sprite size 1
        inc     bc                ;->NEXT_GEN in CPU RAM
        inc     bc
        inc     bc
        inc     bc
        inc     bc
        ex      de,hl             ;HL->FIRST_GEN_NAME
        inc     hl
        ld      a,(hl)
        ld      e,a              ;SV index to VRAM
        ld      d,000H
        push    de
        inc     hl               ;DE=PTRN_PTR
        ld      e,(hl)
        inc     hl
        ld      d,(hl)
        inc     hl               ;CALC & SET NEXT_GEN CPU RAM
        add     a,(hl)
        ld      (bc),a
        ld      c,(hl)
        ld      b,000H
        push    bc
        pop     iy
        ex      de,hl             ;HL->SOURCE PTRN GEN
        pop     de               ;DE=INDEX TO PTRN GEN VRAM
        pop     af
        ret     nc
        ld      a,001H           ;Signal sprite PTRN gen fill
        call    PUT_VRAM_
        ret

```

## PUT/DEFERD PUT OBJ

```
;***** PUTOBJ *****
;
;DESCRIPTION: Putobj vectors to one of 5 specific routines for placing the
;             different object types on the display.
;
;INPUT:       IX = Address of object to be processed
;             B = Parameter to be passed specific put routines
;
; In addition, this module contains routines which allow VRAM operations
; to be deferred, typically until an interrupt occurs, and performed
; in a block by central writer routine.
;
;*****
;
; DATA
; QUEUE_SIZE      DEFS 1      ; 73CA
; This is the size of the deferred write queue. It is set by the
; cartridge programmer. It has range 0 - 255.
;
; QUEUE_HEAD      DEFS 1      ; 73CB
; QUEUE_TAIL      DEFS 1      ; 73CC
; These are the indices of the head and tail of the write queue.
;
; HEAD_ADDRESS    DEFS 2      ; 73CD
; TAIL_ADDRESS    DEFS 2      ; 73CF
; These are the addresses of the queue head and tail.
;
; BUFFER          DEFS 2      ; 73D1
; This is a pointer to the beginning of the deferred write queue. The
; cartridge programmer is responsible for providing a RAM area to hold
; the queue, and passing its location and size to init_queue.
;
; DEFER_WRITES    DEFS 1      ; 73C6
;
; #Defines
TRUE EQU 1
FALSE EQU 0
; Values for boolean deferral_flag.
;
; #Common
; PARAM_AREA      DEFS 3      ; 73BA
; PARAM_AREA is the common parameter passing area for PASCAL entry pts.
;
SET_UP_WRITE:
; SET_UP_WRITE sets up deferred VRAM operation.
;
; Put data in QUEUE_HEAD
push ix
ld hl, (HEAD_ADDRESS)
pop de
ld (hl), e ; Put data pointer
inc hl
ld (hl), d
inc hl
ld (hl), b ; Store PUTOBJ parameter
inc hl
ex de, hl ; HEAD address in DE
ld a, (QUEUE_HEAD)
```

```

        inc     a                ; new HEAD in A
; If QUEUE_HEAD = QUEUE_SIZE then
        ld      hl,QUEUE_SIZE
        cp      (hl)
        jr      nz,NOT_TOO_BIG
; QUEUE_HEAD := 0
        ld      a,000H
        ld      (QUEUE_HEAD),a
; If HEAD_ADDRESS := BUFFER
        ld      hl,(BUFFER)
        ld      (HEAD_ADDRESS),hl
        jr      SET_UP_ENDIF
; Else
NOT_TOO_BIG:
; Store new QUEUE_HEAD
        ld      (QUEUE_HEAD),a
; Store HEAD_ADDRESS
        ld      (HEAD_ADDRESS),de
; End if
SET_UP_ENDIF:
        ret

;
; Procedure INIT_QUEUE (SIZE:BYTE;VAR A_QUEUE:QUEUE)
;
; SIZE passed in A, LOCATION passed in HL
; Destroys: A
INIT_QUEUE_P:
        dw      00002H
        dw      00001H
        dw      0FFFEH
; This is the parameter descriptor for INIT_QUEUEQ
;
; Begin INIT_QUEUE
INIT_QUEUEQ:
        ld      bc,INIT_QUEUE_P
        ld      de,PARAM_AREA
        call    PARAM_
        ld      a,(PARAM_AREA)
        ld      hl,(PARAM_AREA+1)
INIT_QUEUE:
                                ; QUEUE_SIZE := SIZE
        ld      (QUEUE_SIZE),a
                                ; QUEUE_HEAD := QUEUE_TAIL := 0
        ld      a,000H
        ld      (QUEUE_HEAD),a
        ld      (QUEUE_TAIL),a
                                ; BUFFER := TAIL_ADDRESS := HEAD_ADDRESS := LOCATION
        ld      (BUFFER),hl
        ld      (HEAD_ADDRESS),hl
        ld      (TAIL_ADDRESS),hl
; End INIT_QUEUE
        ret

;
; Procedure WRITER_
;
; Takes no parameters
; Destroys: ALL
;
; Begin WRITER_
WRITER_:
                                ; Save deferral flag
        ld      a,(DEFER_WRITES)
        push    af

```

```

                                ; DEFER_WRITES := FALSE
    ld    a,FALSE
    ld    (DEFER_WRITES),a
                                ; While QUEUE_TAIL <> QUEUE_HEAD Do
WRTR_WHILE:
    ld    a,(QUEUE_TAIL)
    ld    hl,QUEUE_HEAD
    cp    (hl)
    jr    z,WRTR_END_WHILE
                                ; Write data at QUEUE_TAIL to VRAM
    ld    hl,(TAIL_ADDRESS)
    ld    e,(hl)                ; ; Get object pointer
    inc    hl
    ld    d,(hl)
    inc    hl
    ld    b,(hl)                ; ; Get parameter
    inc    hl
                                ; Process object in QUEUE
    push    de
    pop     ix
    push    hl
    call    DO_PUTOBJ
                                ; Increment QUEUE_TAIL
    ld    a,(QUEUE_TAIL)
    inc    a
                                ; If QUEUE_TAIL = QUEUE_SIZE Then
    ld    hl,QUEUE_SIZE
    cp    (hl)
    jr    nz,WRTR_ELSE
                                ; QUEUE_TAIL := 0
    ld    a,000H
    ld    (QUEUE_TAIL),a
                                ; TAIL_ADDRESS := BUFFER
    ld    hl,(BUFFER)
    ld    (TAIL_ADDRESS),hl
    pop    hl
    jr    WRTR_END_IF
; Else
WRTR_ELSE:
                                ; Store new QUEUE_TAIL
    ld    (QUEUE_TAIL),a
                                ; TAIL_ADDRESS := TAIL_ADDRESS + 3
    pop    hl
    ld    (TAIL_ADDRESS),hl
                                ; End if
WRTR_END_IF:
    jr    WRTR_WHILE
; End While
WRTR_END_WHILE:
                                ; Restore deferral flag
    pop    af
    ld    (DEFER_WRITES),a
; End WRITER_
    ret
;
; #External
; EXT PUTSEMI, PUT_MOBILE, PUT0SPRITE, PUT1SPRITE, PUTCOMPLEX
; EXT DEFER_WRITES
; EXT PARAM_
PUTOBJ_PAR:
    dw    00002H
    dw    00002H
    dw    00001H

```

```

;
; Procedure PUT_OBJP (VAR DATA:BUFFER;PARAM:BYTE);
; This is the PASCAL entry point to the PUT_OBJ routine
; Input: IX := BUFFER, B := PARAM
;
PUTOBJQ:
    ld    bc,PUTOBJ_PAR
    ld    de,PARAM_AREA
    call  PARAM_
    ld    ix,(PARAM_AREA)
    ld    a,(PARAM_AREA+2)
    ld    b,a
PUTOBJ_:
    ld    a,(DEFER_WRITES)    ; Check if deferred write is desired
    cp    TRUE
    jr    nz,DO_PUTOBJ ; If not, process object
    call  SET_UP_WRITE ; If so, set up for deferred write
    ret
;
DO_PUTOBJ:
    ld    h,(ix+001H)        ; Get address of graphics for OBJ_n
    ld    l,(ix+000H)
    ld    a,(hl)            ; A := OBJ_TYPE
    ld    c,a                ; SAVE COPY in C
    and    00FH              ; Mask for OBJ_TYPE number
    jp    z,PUTSEMI          ; 0 = SEMI_MOBILE
    dec    a
    jp    z,PUT_MOBILE ; 1 = MOBILE
    dec    a
    jp    z,PUT0SPRITE ; 2 = SPRITE0
    dec    a
    jp    z,PUT1SPRITE ; 3 = SPRITE1
    jp    PUTCOMPLEX          ; 4+= COMPLEX

```



## PUT\_SEMI

```

;***** PUT_SEMI *****
;Description: Puts semi_mobile objects on screen
;
;Input:      IX = Address of object to be processed
;           HL = Address of object's graphics tables in ROM
;*****
;
;      GLB      PUTSEMI, PX_TO_PTRN_POS, PUT_FRAME, GET_BKGRND
;
PUTSEMI:
    ld    d,(ix+003H)      ; Get address of status
    ld    e,(ix+002H)
    push  de              ; And put it into IY
    pop   iy
    ld    d,(iy+002H)      ; Get X_LOCATION
    ld    e,(iy+001H)
    call  PX_TO_PTRN_POS
    ld    c,e              ; C := Pattern plane col.
    ld    d,(iy+004H)      ; Get Y_LOCATION
    ld    e,(iy+003H)
    call  PX_TO_PTRN_POS
    ld    b,e              ; B := Pattern plane row
    ld    e,(iy+000H)      ; Get frame number
;
; HL = GRAPHICS_n, IX = OBJ_n, IY = STATUS_n, C = COL., B = ROW, E = FRAME
;
    ld    d,000H          ; DE has frame number
    add   hl,de
    add   hl,de            ; 2*Frame number + Addr of graphics_n
    ld    e,005H          ; Frame pointer offset
    add   hl,de            ; HL now points to location holding address
                        ; of frame
    ld    e,(hl)          ; Get address into DE
    inc   hl
    ld    d,(hl)
    ex    de,hl            ; HL := Address of frame
    push  bc
    pop   de              ; DE := Y_PAT_POS & X_PAT_POS
    ld    c,(hl)          ; C := X_EXTENT
    inc   hl
    ld    b,(hl)          ; B := Y_EXTENT
    inc   hl              ; HL points to 1st name in list
;
; Test to see if OLD_SCREEN is to be saved
;
    ld    a,(ix+005H)      ; Get high byte of OLD_SCREEN address
    bit   7,a              ; Test bit 15 of OLD_SCREEN address
    jr    z,S_OLD_SCRN
    call  PUT_FRAME
    ret
;
S_OLD_SCRN:
    push  bc              ; Save regs
    push  de
    push  hl
    cp    070H
    jr    z,EQUAL_TO
    jr    c,ELSE_1
;    IF    [.A,GE,70H}      ; Then OLD_SCREEN in CPU RAM

```

```

EQUAL_TO:
    ld    h,a
    ld    l,(ix+004H)      ; HL := OLD_SCREEN address
    ld    a,(hl)
    jr    END_IF_1
;
ELSE_1:
    ld    hl,(WORK_BUFFER) ; OLD_SCREEN in VRAM
    ld    d,(ix+005H)      ; Get address of free buffer space
    ld    e,(ix+004H)      ; DE := OLD_SCREEN address
    push  hl                ; Save 2 copies free buffer addr.
    push  de                ; Save OLD_SCREEN addr.
    push  hl
    ld    bc,00004H        ; Read 4 bytes [X,Y_PAT_POSs,X,Y_EXTENTs]
    call  VRAM_READ
    pop   hl                ; HL := Free buffer addr.
    ld    a,(hl)
    cp    080H
    jr    nz,GET_OLD
    pop   de
    jr    SKIP_OLD
;
GET_OLD:
    inc   hl
    inc   hl
    ld    b,(hl)            ; B := X_EXTENT of OLD_SCREEN
    inc   hl
    ld    e,(hl)            ; E := Y_EXTENT
    ld    d,000H
    inc   hl
    ex    de,hl             ; Multiply X_EXTENT*Y_EXTENT in HL
    jr    M_XY+1 ;L0772
;
M_XY:
    add   hl,hl
;L0772:
    djnz  M_XY
    push  hl
    pop   bc                ; BC := Number of bytes to read
    ex    de,hl             ; HL := Free buff addr + 4
    pop   de                ; DE := OLD_SCREEN addr.
    inc   de
    inc   de
    inc   de
    inc   de
    call  VRAM_READ        ; Read saved names for background
SKIP_OLD:
    pop   hl                ; HL := free buffer addr.
END_IF_1:
    ld    a,(hl)            ; A := X_PAT_POS
    cp    080H
    jr    z,END_IF_2
;
IF      [_A,NE,80H]        ; Then there is an OLD_SCREEN
    ld    e,(hl)            ; E := X_PAT_POS
    inc   hl
    ld    d,(hl)            ; D := Y_PAT_POS
    inc   hl
    ld    c,(hl)            ; C := X_EXTENT
    inc   hl
    ld    b,(hl)            ; B := Y_EXTENT
    inc   hl                ; HL points to 1st name in list
    push  ix                ; Save object pointer
    call  PUT_FRAME         ; Restore OLD_SCREEN to display

```

```

        pop        ix                ; Restore object pointer
END_IF_2:
SV1:
        pop        hl                ; HL := Addr. of 1st name in frame
        pop        de                ; DE := Y,X_PAT_POSs
        pop        bc                ; BC := Y,X_EXTENTs
        push       bc
        push       de
        push       hl
        ld         h,(ix+005H)        ; HL := OLD_SCREEN addr.
        ld         l,(ix+004H)
        ld         a,070H
        cp         h
        jr         c,END_IF_3
;       IF         [_H,LT,70H]        ; The OLD_SCREEN now in free buffer
        ld         hl,(WORK_BUFFER)   ; Therefore, move background to buffer
END_IF_3:
        ld         (hl),e            ; OLD_SCREEN + 0 := X_PAT_POS
        inc        hl
        ld         (hl),d            ; OLD_SCREEN + 1 := Y_PAT_POS
        inc        hl
        ld         (hl),c            ; OLD_SCREEN + 2 := X_EXTENT
        inc        hl
        ld         (hl),b            ; OLD_SCREEN + 3 := Y_EXTENT
        inc        hl                ; HL := Addr. to store names
        push       ix                ; Save object pointer
        call       GET_BKGRND
        pop        ix                ; Restore object pointer
        pop        hl                ; Where names are in CPU RAM
        pop        de                ; Where to move then in VRAM [NAME TABLE]
        pop        bc                ; How many to move
        push       ix                ; Save object pointer
        call       PUT_FRAME
        pop        ix                ; Restore object pointer
        ld         d,(ix+005H)        ; See if saved background to be moved to VRAM
SV2:
        ld         a,070H
        cp         d
        jr         z,END_IF_4
        jr         c,END_IF_4
;SV2:: IF         [_D,LT,70H]
        ld         e,(ix+004H)        ; DE := OLD_SCREEN addr.
        exx                    ; Use 'reg for calculation
        ld         hl,(WORK_BUFFER)   ; Where next OLD_SCREEN data is
        push       hl
        inc        hl
        inc        hl
        ld         e,(hl)            ; E := X_EXTENT
        ld         d,000H
        inc        hl
        ld         b,(hl)            ; B := Y_EXTENT
        ex         de,hl              ; HL := X_EXTENT
        jr         M_XY2+1
;
M_XY2:
        add        hl,hl              ; HL := X_EXTENT*Y_EXTENT
;M_XY2+1:
        djnz       M_XY2
        push       hl
        exx
        pop        bc                ; BC := Number of bytes to write
        pop        hl                ; HL := Free buffer addr.
        call       VRAM_WRITE

```

```

END_IF_4:
    ret
; ***** PX_TO_PTRN_POS *****
; Description: Divides reg by 8, If signed result > 127 Then E := Max signed
;               Positiv number. If result < -128, Then E := MIN negative num
; Input:      DE = 16 bit signed number
; Output:     DE/8 < -128      E = -128
;            -128 <= DE/8 <= 127      E = DE/8
;            127 < DE/8          E = 127
; *****
PX_TO_PTRN_POS:
    push    hl                ; HL used to test magnitude
    sra     d                 ; 16 bit shift left
    rr      e
    sra     d
    rr      e
    sra     d                 ; x3
    rr      e
    bit     7,d               ; Is result negative
    jr      nz,NEGTV
    ld      hl,0FF80H         ; Is result > -128
    add     hl,de
    pop     hl
    ret     nc
    ld      e,07FH            ; IF > 128 then E := MAX signed + Num
    ret

;
NEGTV:
    ld      hl,00080H
    add     hl,de
    pop     hl
    ret     c
    ld      e,080H            ; IF < -128 then E := MIN signed - Num
    ret

; ***** PUT_FRAME *****
; Description: The names which constitute a frame are moved to the name table
;               in VRAM. The upper left hand corner of the frame is positioned
;               at X_PAT_POS, Y_PAT_POS.
; Input:      HL = Addr. of list of names [in CPU RAM]
;             D,E = Y_PAT_POS, X_PAT_POS
;             B,C = Y_EXTENT, X_EXTENT
; *****
PUT_FRAME:
    push    bc                ; Copy parameters into primed registers
    push    de
    push    hl                ; And frame address into DE'
    exx
    pop     hl
    pop     de
    pop     bc
    call    CALC_OFFSET
    exx

; %%%
; Test for the following condition:
;           (X_PAT_POS sle 32) and (X_PAT_POS + X_EXTENT sgt 0)
PF1:
    ld      a,e                ; Is X_PAT_POS < 0?
    bit     7,a
    jr      nz,XP_NEG
    cp      020H               ; Is X_PAT_POS < 32?
    ret     nc                 ; If not, return

XP_NEG:
    add     a,c                ; A := X_PAT_POS + X_EXTENT

```

```

        bit    7,a                ; Is A Neg?
        ret    nz                ; If Yes, return
        or     a                 ; Is A = 0?
        ret    z                 ; If Yes, return
X_IN_BOUNDS:
; IF [.E,IS,MINUS] ; IF x_PAT_POS < 0, Frame bleeding on from left
        bit    7,e
        jr     z,ELSE_8
        ld     a,c                ; Calculate amount of frame on screen
        add    a,e                ; A := X_EXTENT + X_PAT_POS
        push   de
        cp     021H              ; If number of names > 32
        jr     c,LT33
        ld     a,020H            ; Then number of names := 32
LT33:
        ld     e,a
        ld     d,000H
        push   de                ; Get count into IY
        pop    iy
        pop    de                ; Restore DE
        ld     a,e                ; A := X_PAT_POS
        exx                     ; Now adjust starting points in frame list and
                                ; name table
        push   bc                ; Save X and Y extent
        neg    bc                ; 2's compliment of X_PAT_POS
        ld     c,a
        ld     b,000H
        add    hl,bc              ; Add displacement to frame pointer
        ex     de,hl
        add    hl,bc              ; Add displacement to name table pointer
        ex     de,hl
        pop    bc
        exx
        jr     END_IF_9
;
ELSE_8:
PF2:
        ld     a,e                ; Is X_PAT_POS + X_EXTENT > 31
        add    a,c
        cp     01FH
        jr     z,ELSE_9
        jr     c,ELSE_9
        ld     a,020H            ; Subtract X_PAT_POS from 31
        sub    e
        push   de
        ld     e,a                ; Get this number into IY
        ld     d,000H
        push   de
        pop    iy
        pop    de
        jr     END_IF_9
; ELSE
                                ; Both ends of frame within pattern plane
ELSE_9:
PF3:
        push   bc
        ld     b,000H
        push   bc
        pop    iy
        pop    bc
END_IF_9:
END_IF_8:
        ld     e,000H
; REPEAT                        ; Y_EXTENT-1 times

```

```

RPT_1:
PF4:
    ld    a,d                ; Get Y_PAT_POS
    add   a,e                ; Add Y
;    IF    [.A,IS,PLUS]
    bit   7,a
    jr    nz,END_IF_10
;    IF    [.A,LE,23]        ; Is 0 <= Y_PAT_POS + Y <= 23
    cp    018H
    jr    nc,END_IF_10
    push  bc
    push  de
    exx
    push  bc
    push  de
    push  hl
    push  iy
    ld    a,002H            ; Code for pattern name table added 4/20
    call  PUT_VRAM_
    pop   iy
    pop   hl
    pop   de
    pop   bc
    exx
    pop   de
    pop   bc
END_IF_10:
    exx
    push  bc
    ld    b,000H            ; Increment pointer into frame by X_EXTENT
    add   hl,bc
    ex    de,hl
    ld    bc,00020H         ; Increment offset by 32
    add   hl,bc
    ex    de,hl
    pop   bc
    exx
    inc   e
;    UNTIL [.E,EQ,.B]        ; Until Y = Y_EXTENT
    ld    a,e
    cp    b
    jr    nz,RPT_1
    ret
; ***** GET_BKGRND *****
; Description: This routine gets the names from the name table which
;              constitute the background in which an object is to be moved
;              at X_PAT_POS, Y_PAT_POS.
; Input:      HL = Location in CPU RAM to which the names are moved
;              E = X_PAT_POS [Left hand column]
;              D = Y_PAT_POS [Top row of pattern]
;              B,C = Y_EXTENT and X_EXTENT of pattern
; *****
GET_BKGRND:
    call  CALC_OFFSET       ; Offset into name table of position of
    push  bc                ; upper left hand pattern
    ld    b,000H            ; Get X_EXTENT into IY
    push  bc                ; number of names per row
    pop   iy
    pop   bc
;    REPEAT                ; Y_EXTENT-1 times
RPT_2:
    push  bc
    push  de

```

```

        push    hl
        push    iy
        ld      a,002H          ; Table code for pattern name table
        call    GET_VRAM_
        pop     iy
        pop     hl
        pop     de
        pop     bc
        push    bc
        ld      b,000H          ; BC := X_EXTENT
        add     hl,bc           ; Point HL to beginning of next row
        ld      bc,00020H
        ex      de,hl
        add     hl,bc           ; Increment offset by 32
        ex      de,hl
        pop     bc
        dec     b
;      UNTIL [.B,EQ,0]
        jr      nz,RPT_2
        ret

; ***** CALC_OFFSET *****
; Description: This routine calculates the proper offset into the name table
;              for the pattern position given by X_PAT_POS, Y_PAT_POS. The
;              formula used is: offset = 32* Y_PAT_POS + X_PAT_POS
; Input:      D,E = Y_PAT_POS, X_PAT_POS
; Output:     DE = Offset
; *****
CALC_OFFSET:
        push    hl
;      IF [.D,IS,MINUS] ; EXTEND SIGN
        bit     7,d
        jr      z,ELSE_11
        ld      h,0FFH
        jr      END_IF_11
;
ELSE_11:
        ld      h,000H
END_IF_11:
        ld      l,d             ; Offset = 32*Y_PAT_POS + X_PAT_POS
        add     hl,hl           ; HL=2*Y_PAT_POS
        add     hl,hl           ;      4*  "
        add     hl,hl           ;      8*  "
        add     hl,hl           ;     16*  "
        add     hl,hl           ;     32*  "
;      IF [.E,IS,MINUS] ; Extend sign
        bit     7,e
        jr      z,ELSE_12
        ld      d,0FFH
        jr      END_IF_12
;
ELSE_12:
        ld      d,000H
END_IF_12:
        add     hl,de           ; HL := 32*Y_PAT_POS + X_PAT_POS
        ex      de,hl           ; DE := 32*Y_PAT_POS + X_PAT_POS
        pop     hl
        ret

; ***** EXTERNALS *****
; EXT GET_VRAM_
; EXT PUT_VRAM_
; EXT VRAM_READ
; EXT VRAM_WRITE
; EXT WORK_BUFFER

```

## ***PUT\_SPRITE RTN***

```
;*****
;
;DESCRIPTION: This module contains code for the PUT1SPRITE and PUT0SPRITE
;             routines. These routines turn out to be essentially the same
;             code with two slightly different entry points
;
;INPUT:      IX = Address of the sprite object
;
; The format for sprite objects is
;
; SPRITE_OBJECT = RECORD
;   GRAPHICS: ^SPRITE_GRAPHICS
;   STATUS: ^SPRITE_STATUS
;   SPRITE_INDEX: BYTE                (SPRITE_NAME_TABLE index of this sprite)
; END SPRITE_OBJECT
;
; SPRITE_GRAPHICS = RECORD
;   OBJECT_TYPE: BYTE
;   FIRST_GEN_NAME: BYTE              (Name of the 1st sprite generators)
;   PTRN_POINTER: ^PATTERN_GENERATOR (Pointer to ROM'ed generators)
;   NUMGEN: BYTE                     (Number of ROM'ed generators)
;   FRAME_TABLE_PTR: ^ARRAY[0..nn] of FRAME (table of animation frames)
; END SPRITE_ROM_GRAPHICS
;
; SPRITE_STATUS = RECORD
;   FRAME: BYTE                      (Current animation frame)
;   X_LOCATION: INTEGER
;   Y_LOCATION: INTEGER
;   NEXT_GEN: BYTE                   (Index of free space in generator table)
; END SPRITE_STATUS
;
; FRAME = RECORD
;   COLOR: BYTE                      (Sprite's color for this frame)
;   SHAPE: BYTE                      (This frame's offset from name from FIRST_GEN_NAME)
; END FRAME
;
; SPRITE = RECORD
;   Y: BYTE
;   X: BYTE
;   NAME: BYTE
;   COLOR_AND_TAG: BYTE
; END SPRITE
;
;*****  DICTIONARY *****
;
; #External
; EXT WORK_BUFFER
; WORK_BUFFER is a pointer in cartridge ROM, located at 8006h, to the
; free buffer area to be used by the graphics routines.
;
; #Defines
;
; SPRITE_PTR EQU    IX
; SPRITE_PTR is a pointer to the new sprite name table entry being
; build by this routine.
;
; THIS_SPRITE EQU    IX
; THIS_SPRITE is a pointer to the sprite object being put.
;
```



```

GRAPHICS          EQU    0
STATUS            EQU    2
SPRITE_INDEX     EQU    4
; Field offsets for SPRITE_OBJECT records.
OBJECT_TYPE       EQU    0
FIRST_GEN_NAME    EQU    1
PTRN_POINTER     EQU    2
NUMGEN           EQU    4
FRAME_TABLE_PTR   EQU    5
; Field offsets for SPRITE_GRAPHICS records.
FRAME            EQU    0
X_LOCATION        EQU    1
Y_LOACTION        EQU    3
NEXT_GEN         EQU    5
; Field offsets for SPRITE_STATUS records.
COLOR            EQU    0
SHAPE            EQU    1
; Field offsets for FRAME records.
Y               EQU    0
X               EQU    1
NAME            EQU    2
COLOR_AND_TAG    EQU    3
; Field offsets for SPRITE records.
;***** External Procedures *****
;
; #External
; EXT  PUT_VRAM, GET_VRAM
; PUT_VRAM (TABLE_CODE:BYTE;START_INDEX,SLICE;BYTE;
;          VAR DATA:BUFFER;ITEM_COUNT:INTEGER);
; GET_VRAM (TABLE_CODE:BYTE;START_INDEX,SLICE;BYTE;
;          VAR DATA:BUFFER;ITEM_COUNT:INTEGER);
;
; PUT_VRAM sends a block of data to the table specified by TABLE_CODE.
; The SLICE, START_INDEX, and ITEM_COUNT are table dependant.
; GET_VRAM does the inverse operation.
;
; TABLE_CODE is passed in A
; START_INDEX,SLICE in DE
; DATA buffer address in HL
; ITEM_COUNT passed in IY
;***** PROCEDURE BODY *****
;
; #Global
; GLB  PUT0SPRITE, PUT1SPRITE

; Begin PUT0SPRITE
PUT0SPRITE:
    ld      iy,(WORK_BUFFER)    ; SPRITE_PTR :=[WORK_BUFFER]
; With THIS_SPRITE^,SPRITE_PTR^ DO
; If (STATUS^.X_LOCATION > -8) And (STATUS^.X_LOCATION < 256) And
;   (STATUS^.Y_LOCATION > -8) And (STATUS^.Y_LOCATION < 192) Then
    ld      l,(ix+STATUS)
    ld      h,(ix+STATUS+1)
    ld      de,X_LOCATION
    add     hl,de                ; [HL] = X_LOCATION
    ld      c,(hl)
    inc     hl
    ld      b,(hl)              ; BC = X_LOCATION
    ld      a,b                 ; Compare BC with -8
    cp      000H
    jr      z,OK__1
    cp      0FFH ; -1
    jp      nz,DONT_PUT

```

```

        ld    a,c
        cp    0F9H    ; -7
        jp    m,DONT_PUT
OK__1:
        inc    hl                ; [HL] = Y_LOCATION
        ld    c,(hl)
        inc    hl
        ld    b,(hl)            ; BC = Y_LOCATION
        ld    a,b                ; Compare BC with -8
        cp    000H
        jr    z,OK__2
        cp    0FFH    ; -1
        jp    nz,DONT_PUT
        ld    a,c
        cp    0F9H    ; -7
        jp    m,DONT_PUT
OK__2:
; If (STATUS^.X_LOCATION < 0) Then
        dec    hl
        dec    hl                ; [HL] = HI(X_LOCATION)
        ld    a,(hl)            ; Compare with 0
        cp    000H
        jp    z,CONTINUE
; X := BYTE(STATUS^.X_LOCATION) + 8
        dec    hl                ; [HL] = ^X_LOCATION
        ld    c,(hl)
        inc    hl
        ld    b,(hl)
        ld    hl,00008H
        add    hl,bc
        ld    a,l
        ld    (iy+X),a
; COLOR_AND_TAG := GRAPHICS^.FRAME_TABLE[STATUS^.FRAME].COLOR Or 80h
        ld    l,(ix+GRAPHICS)
        ld    h,(ix+GRAPHICS+1)
        ld    de,FRAME_TABLE_PTR
        add    hl,de                ; [HL] = FRAME_TABLE_PTR
        ex    hl
        ld    a,(de)
        ld    l,a
        inc    de
        ld    a,(de)
        ld    h,a                ; [HL] = FRAME_TABLE_PTR^
        push    hl
        ld    l,(ix+STATUS)
        ld    h,(ix+STATUS+1)
        ld    de,FRAME
        add    hl,de                ; [HL] = FRAME
        ld    a,(hl)                ; Calculate offset of
        sla    a                    ; COLOR entry
        ld    bc,00000H
        ld    c,a
        pop    hl
        add    hl,bc                ; [HL] = COLOR
        ld    a,(hl)                ; Or in 80h
        or    080H
        ld    (iy+COLOR_AND_TAG),a
        jp    PUT_Y_AND_NAME
; Else
; ***** Continue below
; Begin PUT1SPRITE
PUT1SPRITE:
        ld    iy,(WORK_BUFFER)    ; SPRITE_PTR :=[WORK_BUFFER]

```

```

; With THIS_SPRITE^,SPRITE_PTR^ DO
; If (STATUS^.X_LOCATION > -32) And (STATUS^.X_LOCATION < 256) And
; (STATUS^.Y_LOCATION > -32) And (STATUS^.Y_LOCATION < 192) Then
    ld    l,(ix+STATUS)
    ld    h,(ix+STATUS+1)
    ld    de,X_LOCATION
    add   hl,de                ; [HL] = X_LOCATION
    ld    c,(hl)
    inc   hl
    ld    b,(hl)              ; BC = X_LOCATION
    ld    a,b                ; Compare BC with -32
    cp    000H
    jr    z,OK__3
    cp    0FFH ; -1
    jp    nz,DONT_PUT
    ld    a,c
    cp    0E1H ; -31
    jp    m,DONT_PUT
OK__3:
    inc   hl                ; [HL] = Y_LOCATION
    ld    c,(hl)
    inc   hl
    ld    b,(hl)              ; BC = Y_LOCATION
    ld    a,b                ; Compare BC with -32
    cp    000H
    jr    z,OK__4
    cp    0FFH ; -1
    jp    nz,DONT_PUT
    ld    a,c
    cp    0E1H ; -31
    jp    m,DONT_PUT
OK__4:
; If STATUS^.X_LOCATION < 0 Then
    dec   hl
    dec   hl                ; [HL] = HI(X_LOCATION)
    ld    a,(hl)              ; Compare with 0
    cp    000H
    jp    z,CONTINUE
; X := BYTE(STATUS^.X_LOCATION) + 32
    dec   hl                ; [HL] = ^X_LOCATION
    ld    c,(hl)
    inc   hl
    ld    b,(hl)
    ld    hl,00020H          ; 32
    add   hl,bc
    ld    a,l
    ld    (iy+X),a
; COLOR_AND_TAG := GRAPHICS^.FRAM_TABLE[STATUS^.FRAME].COLOR Or 80h
    ld    l,(ix+GRAPHICS)
    ld    h,(ix+GRAPHICS+1)
    ld    de,FRAME_TABLE_PTR
    add   hl,de                ; [HL] = FRAME_TABLE_PTR
    ex    de,hl
    ld    a,(de)
    ld    l,a
    inc   de
    ld    a,(de)
    ld    h,a                ; [HL] = FRAME_TABLE_PTR^
    push  hl
    ld    l,(ix+STATUS)
    ld    h,(ix+STATUS+1)
    ld    de,FRAME
    add   hl,de                ; [HL] = FRAME

```

```

        ld    a,(hl)                ; Calculate offset of
        sla   a                    ; COLOR entry
        ld    bc,00000H
        ld    c,a
        pop   hl
        add   hl,bc                ; [HL] = COLOR
        ld    a,(hl)                ; Or in 80h
        or    080H
        ld    (iy+COLOR_AND_TAG),a
        jr    PUT_Y_AND_NAME
; Else
; ***** Continue from here
CONTINUE:
; X := BYTE(STATUS^.X_LOCATION)
        ld    l,(ix+STATUS)
        ld    h,(ix+STATUS+1)
        ld    de,X_LOCATION
        add   hl,de                ; [HL] = X_LOCATION
        ld    a,(hl)
        ld    (iy+X),a
; COLOR_AND_TAG := GRAPHICS^.FRAME_TABLE[STATUS^.FRAME].COLOR
        ld    l,(ix+GRAPHICS)
        ld    h,(ix+GRAPHICS+1)
        ld    de,FRAME_TABLE_PTR
        add   hl,de                ; [HL] = FRAME_TABLE_PTR
        ex    de,hl
        ld    a,(de)
        ld    l,a
        inc   de
        ld    a,(de)
        ld    h,a                ; [HL] = FRAME_TABLE_PTR^
        push  hl
        ld    l,(ix+STATUS)
        ld    h,(ix+STATUS+1)
        ld    de,FRAME
        add   hl,de                ; [HL] = FRAME
        ld    a,(hl)                ; Calculte offset of
        sla   a                    ; COLOR entry
        ld    bc,00000H
        ld    c,a
        pop   hl
        add   hl,bc                ; [HL] = Color
        ld    a,(hl)
        ld    (iy+COLOR_AND_TAG),a
; End if
PUT_Y_AND_NAME:
; Y := BYTE(STATUS^.Y_LOCATION)
        ld    l,(ix+STATUS)
        ld    h,(ix+STATUS+1)
        ld    de,Y_LOCATION
        add   hl,de                ; [HL] = Y_LOCATION
        ld    a,(hl)
        ld    (iy+Y),a
; NAME := GRAPHICS^.FRAME_TABLE[STATUS^.FRAME].SHAPE
;         + GRAPHICS^.FIRST_GEN_NAME
        ld    l,(ix+GRAPHICS)
        ld    h,(ix+GRAPHICS+1)
        ld    de,FRAME_TABLE_PTR
        add   hl,de                ; [HL] = FRAME_TABLE_PTR
        ex    de,hl
        ld    a,(de)
        ld    l,a
        inc   de

```

```

        ld    a,(de)
        ld    h,a                ; [HL] = FRAME_TABLE_PTR^
        push  hl
        ld    l,(ix+STATUS)
        ld    h,(ix+STATUS+1)
        ld    de,FRAME
        add   hl,de              ; [HL] = FRAME
        ld    a,(hl)            ; Calculate offset of
        sla   a                 ; SHAPE entry
        ld    bc,00000H
        ld    c,a
        pop   hl
        add   hl,bc
        inc   hl                ; [HL] = SHAPE
        ld    a,(hl)
        ld    l,(ix+GRAPHICS)
        ld    h,(ix+GRAPHICS+1)
        ld    de,FIRST_GEN_NAME
        add   hl,de             ; [HL] = FIRST_GEN_NAME
        add   a,(hl)
        ld    (iy+NAME),a
; PUT_VRAM (0,THIS_SPRITE^.SPRITE_INDEX,SPRITE_PTR,1)
        xor   a
        ld    d,000H
        ld    e,(ix+SPRITE_INDEX)
        push  iy
        pop   hl
        ld    iy,00001H        ; Count of one item
        call  PUT_VRAM
        jr    EXIT_PUT_SPR
; Else
DONT_PUT:    ; Put sprite off the screen by setting its X and early cloack
; GET_VRAM (0,THIS_SPRITE^.SPRITE_INDEX,SPRITE_PTR,1)
        push  iy                ; Save index regs.
        push  ix
        push  iy
        push  iy
        xor   a
        ld    d,000H
        ld    e,(ix+SPRITE_INDEX)
        pop   hl
        ld    iy,00001H        ; Count of one item
        call  GET_VRAM
; SPRITE_PTR.X :=0
        ld    a,000H
        pop   iy
        ld    (iy+X),a
; SPRITE_PTR.COLOR_AND_TAG := 80h
        ld    a,080H
        ld    (iy+COLOR_AND_TAG),a
; PUT_VRAM (0,THIS_SPRITE^.SPRITE_INDEX,SPRITE_PTR,1)
        xor   a
        ld    d,000H
        pop   ix
        ld    e,(ix+SPRITE_INDEX)
        pop   hl
        ld    iy,00001H        ; Count of one item
        call  PUT_VRAM
; End if
; End PUT0SPRITE,PUT1SPRITE
EXIT_PUT_SPR:
        ret

```

## PUT MOBILE

```

;***** MODIFIED VERSION TO RUN ON HP ASSEMBLER *****
;
;                                     4/16/82
;                                     13:50:00
;***** PUT_MOBILE *****
;
;DESCRIPTION: This procedure places a mobile object on the pattern plane
;             at the X,Y pixel localisation specified in that objet's RAM
;             status AREA.
;
;             A buffer area of 204 bytes (graphics mode II) or 141 bytes
;             (graphics mode I) is required for forming the new generators
;             representing the object on it's background_ the procedure
;             uses RAM starting at (F_BUF_SPACE) for this buffer
;
;INPUT:       IX = Address of object to be processed
;             HL = Address of object's graphics tables in ROM
;             B  = Selector for methode of combining object generators
;                 with background generators
;
;-----
;METHODE OF COMBINING OBJECT GENERATORS:
;
;             1 = Object pattern gens ored with background pattern gens
;                 color1 of background changed to mobile object's color
;                 if corresponding pattern byte not zero
;
;             2 = Replace background pattern gens with object pattern gens
;                 treat color same as #1
;
;             3 = Same as #1 except color0 changed to transparent
;
;             4 = Same as #2 except color0 changed to transparent
;
;*****
; }
;     EXT    READ_VRAM,WRITE_VRAM,WORK_BUFFER,GET_VRAM,PUT_VRAM
;     EXT    PX_TO_PTRN_POS,GET_BKGRND,VDP_MODE_WORD,PUTFRAME
;     GLB    PUT_MOBILE
;
; #Defines
; The following are offsets from the start of the free buffer area
; These locations used to store variables and pattern and color data
YDISP      EQU    0      ;Y Displacement
XDISP      EQU    1      ;X Displacement
COLR       EQU    2      ;Color
FLAGS      EQU    3      ;BITS 0,1=Selector#, BIT X = Graphics Mode (I/II)
FRM        EQU    4      ;Frame to be Displayed
F_GEN      EQU    5      ;Name of 1st generator in object's gen table
YP_OS      EQU    7      ;Y_PAT_POS of OLD_SCREEN
XP_OS      EQU    6      ;X_PAT_POS of OLD_SCREEN
YP_BK      EQU    18     ;Y_PAT_POS of BACKGROUND ;12h
XP_BK      EQU    17     ;X_PAT_POS of BACKGROUND ;11h
BK_PTN EQU 28      ;Start of background pattern generators ; 1Ch
OBJ_PTN EQU 100     ;Start of object's pattern generators ; 64h
BK_CLR EQU 132     ;Start of background color generators ; 84h

PUT_MOBILE:
    ld      iy,(WORK_BUFFER)      ; Get start of free buffer area
    ld      a,(VDP_MODE_WORD)     ; Find out which graphics mode we are in

```

```

        bit    1,a
        jr     nz,ELSE1          ; Then Mode I
        res    7,b
        jr     END1

;
ELSE1:                                ; Else Mode II
        set    7,b
END1:
        ld     (iy+FLAGS),b        ; Save Selector
        push   hl                  ; Save graphics address
        ld     h,(ix+003H)         ; HL := ADDR_ of status
        ld     l,(ix+002H)
        ld     a,(hl)              ; Get frame #
        ld     (iy+FRM),a         ; And save
        xor    080H               ; Complement table_in_use flag
        ld     (hl),a             ; Save back in status area
        inc    hl                  ; point to X_LOCATION
        ld     e,(hl)             ; E := Low X_LOCATION
        ld     a,e
        and    007H               ; A := #Pixels to right of pattern boundary
        neg
        add    a,008H             ; Amount to shift pattern left
; from next pat boundary
        ld     (iy+XDISP),a        ; Save
        inc    hl
        ld     d,(hl)             ; DE := X_LOCATION
        call   PX_TO_PTRN_POS      ; Calculate X_PAT_POS of background
        ld     (iy+XP_BK),e        ; And Save
        inc    hl                  ; Point to Y_LOCATION
        ld     e,(hl)             ; E := Low Y_LOCATION
        ld     a,e
        and    007H               ; A := #Pixels to right of pattern boundary
        ld     (iy+YDISP),a        ; Save
        inc    hl
        ld     d,(hl)             ; DE := Y_LOCATION
        call   PY_TO_PTRN_POS      ; Calculate Y_PAT_POS
        ld     (iy+YP_BK),e        ; And Save
; Now get the nine names that constitute the background on which
; the mobile object will be superimposed
PM1:
        ld     hl,(WORK_BUFFER)
        ld     de,YP_BK+1          ; Point to space for background names
        add    hl,de
        ld     d,(iy+YP_BK)        ; D := Y_PAT_POS
        ld     e,(iy+XP_BK)        ; E := X_PAT_POS
        ld     bc,00303H          ; B := Y_EXTENT, C := X_EXTENT
        call   GET_BKGRND          ; Get background names
; Read old screen into buffer and get COLOR and 1st GEN_NAME
PM2:
        ld     d,(ix+005H)         ; DE := OLD_SCREEN address
        ld     e,(ix+004H)
        ld     a,(ix+006H)         ; Get first GEN_NAME
        pop    ix                  ; IX := Address of graphics
        ld     iy,(WORK_BUFFER)
        ld     (iy+F_GEN),a        ; Save in buffer
        push   de                  ; Save OLD_SCREEN address
        ld     hl,(WORK_BUFFER)    ; HL := Addr of start of buffer
        ld     bc,XP_OS           ; Space to move OLD_SCREEN to
        add    hl,bc
        ld     bc,0000BH          ; Get 9 names from VRAM
                                   ; Then OLD_SCREEN is in VRAM

        ld     a,d
        cp     070H

```

```

        jr      nc,ELSE2
        call    READ_VRAM
        jr      END2
; ELSE                                     ; OLD_SCREEN in CPU RAM
ELSE2:
        ex      de,hl
        ldir
END2:

; At this point, IX = GRAPHICS, [SP] = OLD_SCREEN
; BACKGROUND pattern position and names starting at YP_BK
; OLD_SCREEN pattern position and names starting at YP_OS
; Find all names in background which
;   belong to this object's pattern generator
; And replace with name from OLD_SCREEN which
;   corresponds to that pattern position
PM3:
        ld      hl,(WORK_BUFFER)          ; HL := BUFFER BASE
        ld      de,YP_BK+1
        add     hl,de                      ; Point to 1st of background names
        exx
        ld      de,(WORK_BUFFER)          ; DE' := BUFFER BASE
        ld      hl,YP_OS+1
        add     hl,de
        ex      de,hl                      ; Points to 1st of OLD_SCREEN names
        exx
        ld      iy,(WORK_BUFFER)
        ld      c,(iy+F_GEN)              ; C := FIRST_GEN_NAME
        ld      b,009H
DLP1:
        ld      a,(hl)                    ; Get a name
        sub     c                          ; Subtract FIRST_GEN_NAME
; If [_A,LT,18]                            ; Then name falls in range of names for object
        cp      012H
        jr      nc,END3
; If [_A,GE,9]                            ; Then sub 9 to find correct
        cp      009H
        jr      c,END4
        sub     009H                      ; Position in OLD_SCREEN
END4:  ; ENDDIF
        exx
        ld      l,a                        ; Form a pointer into OLD_SCREEN names
        ld      h,000H
        add     hl,de
        ld      a,(hl)                    ; Get OLD_SCREEN NAME
        exx
        ld      (hl),a                    ; Replace background name with OLD_SCREEN name
END3:
        inc     hl                          ; Point to next name in background
        djnz    DLP1

; Now new version of background names will not contain any names of this object
; Replace previous version of OLD_SCREEN with this new background
PM4:
        pop     de                          ; DE := OLD_SCREEN address
        ld      hl,(WORK_BUFFER)          ; HL := BUFFER base
        ld      bc,XP_BK
        add     hl,bc                      ; HL points to background position and names
        ld      bc,0000BH                  ; Number of bytes to move
; if [_D,LT,70H]                          ; Then move data to VRAM
        ld      a,d
        cp      070H
        jr      nc,ELSE5

```



```

        call    WRITE_VRAM
        jr      END5
;
; Else
ELSE5:                                     ; Move to CPU RAM
        ldir
;
        ENDF
END5:
        push    ix                        ; Save graphics pointer
PM5:
        ld      de,(WORK_BUFFER)         ; DE := BUFFER base
        ld      hl,YP_BK+1               ; Displacement to beginning of BKGND names
        add     hl,de
        ex      de,hl                    ; DE point to first background name
        ld      bc,BK_PTN-8              ; HL points to background PAT GET storage area
-8
        add     hl,bc                     ; will be incremented before 1st use
        ld      b,009H
DLP2:
        ld      a,(de)                    ; Get name
        inc     de                        ; point to next name
        push    de                        ; Save name pointer
        ld      de,00008H                 ; increment BUFFER pointer
        add     hl,de
        push    hl                        ; Save BUFFER pointer
        ld      e,a                       ; Index into pattern table
        ld      d,000H
        ld      c,a                       ; Save pattern name in C
        push    bc                        ; Save counter
        ld      a,009H                    ; ADD [b-9]/3 to YP_BK to find out
        sub     b                          ; which third of tables GENs are in
        ld      b,000H
PM52:
        sub     003H
        jr      c,PM51
        inc     b
        jr      PM52
;
PM51:
        ld      a,b
        ld      iy,(WORK_BUFFER)
        add     a,(iy+YP_BK)
        bit     7,(iy+FLAGS)              ; Test graphics mode
        ld      iy,00001H                 ; Number of elements read
PM6:    ; IF [PSW,IS,ZERO]                  ; Then MODE I
        jr      nz,ELSE6
        ld      a,003H                     ; Code for pattern generator table
        call    GET_VRAM
        pop     bc                         ; Get count and name
        ld      hl,(WORK_BUFFER)
        push    bc
        ld      de,BK_CLR                  ; Displacement to COLOR GEN AREA
        add     hl,de                      ; Point to it
        ld      e,c                       ; Pattern name
        srl     e                          ; Divide name by 8
        srl     e
        srl     e
        ld      d,000H
        ld      a,009H                     ; Calc position in buffer to move GEN to
        sub     b
        ld      c,a
        ld      b,000H
        add     hl,bc
        ld      iy,00001H

```

```

        ld    a,004H                ; Color generator table code
        call  GET_VRAM
        jr    END6
;
ELSE6: ; ELSE                ; MUST BE MODE II
        sra   a                    ; Divide Y_POS by 8
        sra   a
        sra   a                    ; A:= Third of table, 0=1st, 1=2nd, 2=3rd
PM7:    ; IF [_A,LT,3]          ; If A>2, Then Y_POS > 23 And Therefore off
screen
        cp    003H
        jr    nc,END7
        ld    d,a                  ; DE := 256*A + NAME
        push  de                    ; Save it
        push  hl
        ld    a,003H                ; Pattern generator table code
        call  GET_VRAM
        pop   hl                    ; HL := Pattern buffer address
        ld    de,BK_CLR-BK_PTN      ; Displacement between pattern and color
buffers
        add   hl,de                 ; HL := Pointer to color buffer
        pop   de
        ld    iy,00001H
        ld    a,004H                ; Code for color table
        call  GET_VRAM
END7:
END6:
        pop   bc                    ; Restore registers
        pop   hl
        pop   de
        djnz  DLP2

; Now the pattern and color generators are in their respective buffers
; So get the four generators for this frame of the object

        pop   ix                    ; Restore graphics pointer
PM8:
        exx
        ld    d,(ix+003H)
        ld    e,(ix+002H)            ; DE' := NEW_GEN
        ld    b,(ix+005H)
        ld    c,(ix+004H)            ; BC' := PTRN_POINTER
        exx
        push  ix
        pop   hl                    ; HL := Address of graphics
        ld    iy,(WORK_BUFFER)
        ld    a,(iy+FRM)              ; A := FRM #
        add   a,a                    ; X2
        ld    c,a
        ld    b,000H
        ld    de,00006H              ; Frame pointers start at this offset
        add   hl,de
        add   hl,bc                  ; HL := Points to FRAME_POINTER for frame
        ld    e,(hl)
        inc   hl
        ld    d,(hl)                ; DE := Address of frame names
        ld    hl,(WORK_BUFFER)        ; HL := Buffer base address
        ld    bc,OBJ_PTN+24          ; Use location for last GEN to store names
        add   hl,bc
        push  hl                    ; Save for later use
        push  bc                    ; Save offset
        ld    bc,00005H
;    IF [_D,LT,70H]                ; Then names are in VRAM

```

```

        ld    a,d
        cp    070H
        jr    nc,ELSE8
        call  READ_VRAM                ; Get the 4 names
        jr    END8
; ELSE                                     ; Names in CPU memory space
ELSE8:
        ex    de,hl
        ldir
END8:
        ld    iy,(WORK_BUFFER)        ; Get color byte
        pop    bc                      ; Offset to 1st name
        add    iy,bc
        ld    a,(iy+004H)              ; A := Color Byte
        ld    iy,(WORK_BUFFER)
        ld    (iy+COLR),a              ; COLOR := Color Byte
PM9:
        pop    de                      ; DE := Address of 1st name in buffer
        ld    hl,(WORK_BUFFER)         ; HL := buffer base address
        ld    bc,OBJ_PTN               ; Start of object's pattern buffer
        add    hl,bc
        ld    b,004H                  ; Get 4 patterns corresponding to the 4 names
DLP4:
        ld    a,(de)                  ; Get name
        cp    (ix+001H)                ; Compare to NUMGEN
        push   de                      ; Save pointer to names
; IF [PSW,IS,CARRY]                    ; The name < numgen, therefore
        jr    nc,ELSE9
        exx                             ; Pattern part of graphics tables
        add    a,a
        add    a,a
        add    a,a                      ; A := 8*Name
        ld    l,a
        ld    h,000H
        add    hl,bc                   ; HL := Pointer to Pattern
        push   hl
        exx
        pop    de                      ; DE := " "
        ex    de,hl
        push   bc
        ld    bc,00008H                ; Number of bytes to move
        ldir
        pop    bc
        ex    de,hl
        jr    END9
; ELSE                                     ; Name => Numgen, therefore not part of ROMed Gens
ELSE9:
        sub    (ix+001H)                ; Subtract Numgen from NAME
        exx
        add    a,a
        add    a,a
        add    a,a                      ; A := 8*NAME
        ld    l,a
        ld    h,000H                  ; HL := Pointer to pattern
        add    hl,de
        push   hl
        exx
        pop    de
; IF [_D,LT,70H]                        ; Then pattern in VRAM
PM10:
        ld    a,d
        cp    070H
        jr    nc,ELSE10

```

```

        push    bc
        push    hl                ; Save buffer address
        push    de                ; Save generator address
        ld      bc,00008H        ; Number bytes to move
        call    READ_VRAM
        ld      bc,00008H        ; Increment pointers by 8
        pop     hl
        add     hl,bc            ; Gen addr := Gen addr + 8
        ex      de,hl
        pop     hl
        add     hl,bc            ; Bug addr := Buf addr + 8
        pop     bc
        jr      END10
;      ELSE                ; Pattern in CPU RAM
ELSE10:
        ex      de,hl
        push    bc
        ld      bc,00008H
        ldir
        pop     bc
        ex      de,hl
END10:
END9:
        pop     de
        inc     de
        djnz    DLP4

; Combine object pattern generators with background
PM11:
        ld      iy,(WORK_BUFFER)
        ld      de,(WORK_BUFFER)    ; DE := Buffer base addr_
        ld      hl,BK_PTN
        add     hl,de                ; HL points to start of background generators
        ld      c,(iy+YDISP) ; BC :=
        ld      b,000H              ; Displacement of object below pattern generators
        add     hl,bc                ; HL points to 1st row in background
;      to be overlayed
        push    hl
        pop     ix                ; IX := pointer to row in pattern buffer
        ld      hl,OBJ_PTN
        add     hl,de                ; HL points to 1st byte in object's pattern
gen
        push    hl
        ld      a,010H              ; Use A' as loop counter
        ex      af,af'
COMBINE_LOOP:
        pop     hl                ; Point to object pattern byte
        ld      d,(hl)            ; Get pattern byte
        inc     hl
        push    hl
        ld      bc,0000FH
        add     hl,bc                ; Point to adjacent pattern byte
        ld      e,(hl)
        ex      de,hl              ; HL has 16 bit row of object's pattern
        ld      b,(iy+XDISP)        ; Shift left pattern by this amount
        xor     a                    ; Clear A
SHFLP:
        dec     b
        jp      m,SHFEX
        add     hl,hl
        rla
        jr      SHFLP
;

```

```

SHFEX:
    ld    e,a                ; Save left byte in E
    call  COM_PAT_COL
    ld    a,(iy+YDISP)       ; Increment YDISP
    inc   a
    ld    (iy+YDISP),a
    cp    008H
    jr    z,IF11
    cp    010H
    jr    nz,END11
IF11:
    ld    bc,00010H
    add   ix,bc              ; Beginning of next row
END11:
    inc   ix                ; Point to next gen byte
    ex    af,af'
    dec   a                ; Decrement loop counter
    jr    z,C_LP_EXIT
    ex    af,af'
    jr    COMBINE_LOOP
;
C_LP_EXIT:
    pop    hl                ; POP Pointer off stack
    bit    7,(iy+FLAGS)      ; Test for mode 1
;    IF [PSW,IS,ZERO]        ; Then update mode 1color Gens
    jr    nz,END12
    ld     hl,(WORK_BUFFER)
    ld     bc,BK_CLR        ; Offset for color buffer
    add    hl,bc             ; HL points to start of color buffer
    ld     d,(iy+COLR)      ; Get object color
    bit    1,(iy+FLAGS)     ; Color0 = background or transparent ?
;    IF [PSW,IS,ZERO]        ; Then use background color0
    jr    nz,ELSE13
    ld     c,00FH           ; Mask for color0 of background
    jr     END13
;    ELSE
ELSE13:
    ld     c,000H           ; Mask replace color0 with transparent
;    ENDIF
END13:
    ld     b,009H           ; Change all 9 color bytes
DLP5:
    ld     a,(hl)           ; Get background color gen
    and    c                ; Mask out color1
    or     d                ; Add object color1
    ld     (hl),a           ; Update color generator
    inc    hl              ; Point to next color gen
    djnz   DLP5
END12:
; Decide which part of object's pattern and color tables to use
    ld     a,(iy+F_GEN)     ; Get name of 1st generator in object's table
    bit    7,(iy+FRM)       ; Test which part of table to use
;    IF [PSW,IS,NZERO]      ; Then use upper half of tables
    jr     z,END14
    add    a,009H
;    ENDIF
END14:
; Change names in background buffer to those of the object's patterns
; This will then constitute a new frame displaying the object at pattern plane
; location [YP_BK],[XP_BK]
    ld     c,a              ; Save index
    ld     hl,(WORK_BUFFER) ; HL := Buffer base

```

```

        ld    de,YP_BK+1          ; Point to 1st background name
        add   hl,de
        ld    b,009H
DLP6:   ld     (hl),a
        inc   a
        inc   hl
        djnz  DLP6
; Move newly formed generators to object's pattern and color gen tables
PM12:   bit    7,(iy+FLAGS)        ; Test which mode
;       IF [PSW,IS,ZERO]          ; Then mode 1
        jr    nz,ELSE04
        ld    e,c
        ld    d,000H              ; DE := Index into pattern generator table
        ld    hl,(WORK_BUFFER)
        ld    bc,BK_PTN
        add   hl,bc               ; HL points to 1st generator
        ld    iy,00009H          ; 9 elements to send
        ld    a,003H             ; Code for pattern generator table
        call  PUT_VRAM
; Set up pointers to object's pattern names and to color gen bytes
        ld    iy,(WORK_BUFFER)
        ld    hl,(WORK_BUFFER)   ; HL := buffer base
        ld    bc,BK_CLR          ; Offset to color buffer
        add   hl,bc              ; HL points to color buffer
        ld    ix,(WORK_BUFFER)   ; IX := buffer base
        ld    bc,YP_BK+1         ; Offset to 1st name for object
        add   ix,bc              ; IX points to 1st name
        ld    b,009H
; Repeat
RPT1:   ; Move colors to color generator table
        ld    a,(ix+000H)        ; Get name
        inc   ix                 ; Point to next name
        srl   a                  ; Divide by 8
        srl   a
        srl   a
        ld    e,a
        ld    d,000H            ; DE := Offset into color gen table
        push  bc                 ; Save counter
        ld    a,009H            ; Test whether this pattern position is
        sub   b                  ; on the screen or not (i.e. is YP.BK
        ld    b,000H            ; + (B-9)/3 between 0 and 23, and is
DVLP:   cp    003H               ; XP.BAK + (B-9)/3 mod 3 between 0 and 31)
        jr    c,DVEX
        sub   003H
        inc   b
        jr    DVLP
;
DVEX:   add   a,(iy+XP_BK)        ; A := X_POS + (B-9)/3 mod 3
        cp    020H
        jr    nc,NOTOS
        ld    a,b
        add   a,(iy+YP_BK)       ; A := Y_POS + (B-9)/3
        cp    018H              ; Is this position on screen 7
        jr    nc,NOTOS
        push  ix                 ; And pointers
        push  hl
        ld    a,004H            ; Code for color generator table
        ld    iy,00001H         ; Number of items to send
        call  PUT_VRAM

```

```

        pop    hl                ; Restore pointers
        pop    ix
NOTOS:
        pop    bc                ; And counter
        inc    hl                ; Increment pointers
        inc    de
        dec    b                ; Decrement counter
        ld     a,b
        cp     000H
        jr     nz,RPT1
; UNTIL [_B,EQ,0]
        ld     iy,(WORK_BUFFER) ; Restore buffer addr
        jr     END04
;
ELSE04:
PM13:
        ld     b,000H
RPT2:
        push   bc                ; Save counter and index
        ld     a,c                ; Add 3xcounter to index,
        add    a,b                ; where next gens to be moved
        add    a,b
        add    a,b
        ld     c,a                ; C := Index to table location for next 3 gens
        ld     hl,00000H          ; Calculate offsets from start of pattern
        ld     de,00018H          ; and color generator tables
        ld     a,b
AD_LP:
        dec    a
        jp     m,AD_EXIT
        add    hl,de
        jr     AD_LP
; HL := Offset from start of ptrn and color buffers
AD_EXIT:
        ld     iy,(WORK_BUFFER)
        ld     a,(iy+YP_BK) ; Get Y_PAT_POS to see which 3rd of tables to use
        add    a,b                ; each group of 3 in next pattern plane row
; IF [_A,LT,24] ; 'A' must contain valid Y_PAT_POS [0-23]
        cp     018H
        jr     nc,END15
        srl    a                ; This number / 8 indicates which 1/3 of
        srl    a                ; table to use
        srl    a
        ld     d,a
        ld     e,c                ; DE := Index into pattern and color tables
        push   de                ; Save index
        ld     bc,BK_PTN          ; Form pointer to generators in HL
        add    hl,bc
        ld     bc,(WORK_BUFFER) ; Get buffer base addr
        add    hl,bc
        push   hl                ; Save this pointer
        ld     iy,00003H          ; Number of elements to move
        ld     a,003H            ; Pattern generator table code
        call   PUT_VRAM
        pop    hl                ; Get pointer back
        ld     de,BK_CLR-BK_PTN ; Offset between buffers
        add    hl,de                ; HL points to start of next 3 color generators
        pop    de                ; Get index into gen tables
        ld     iy,00003H
        ld     a,004H
        call   PUT_VRAM
END15:
        pop    bc                ; Restore counter and index

```

```

        inc    b
        ld     a,b
        cp     003H
        jr     nz,RPT2
;       IF [_B,EQ,3] ; Repeat 3 times
END04:

; Restore OLD_SCREEN if it's Y_PAT_POS and X_PAT_POS differs from the
; Y_PAT_POS and X_PAT_POS for the object
PM14:
        ld     iy,(WORK_BUFFER)
        ld     b,(iy+XP_OS)          ; Test for valid OLD_SCREEN data
;       IF [_B,NE,80H]              ; Then there is valid data
        ld     a,b
        cp     080H
        jr     z,END16
        ld     c,(iy+YP_OS)          ; Test if OS position same as current position
        ld     h,(iy+XP_BK)
        ld     l,(iy+YP_BK)
        or     a                     ; Clear the carry
        sbc    hl,bc                 ; Is there any difference?
;       IF [PSW,IS,NZERO]           ; Then position has changed
        jr     z,END17
        ld     hl,(WORK_BUFFER)      ; Get buffer base
        ld     de,YP_OS+1
        add    hl,de                 ; Point to OLD_SCREEN names
        ld     e,(iy+XP_OS)
        ld     d,(iy+YP_OS)          ; DE := X and YPAT_POS
        ld     bc,00303H             ; BC := X and Y EXTENT
        call   PUT_FRAME
END17:
END16:
; Place object on screen
        ld     iy,(WORK_BUFFER)
        ld     hl,(WORK_BUFFER)      ; HL := Buffer base addr
        ld     de,YP_BK+1            ; Point to names for object
        add    hl,de
        ld     e,(iy+XP_BK)
        ld     d,(iy+YP_BK)          ; DE := A and Y PAT_POS
        ld     bc,00303H             ; BC := X and Y EXTENT
        call   PUT_FRAME
; ***** END OF PUT_MOBILE *****
        ret
; Regs A, H and L contain 24 bit pattern to be combined with background
; generators. IX points to the 1st of 3 generator bytes to be combined
; with A, H and L
COM_PAT_COL:
        bit    0,(iy+FLAGS)          ; 'OR' gens or replace
;       IF [PSW,IS,ZERO]            ; Then 'OR'
        jr     nz,ELSE18
        or     (ix+000H)              ; 'OR' left byte with background
        ld     (ix+000H),a            ; Substitute for that generator byte
        ld     a,h                    ; Now do middle byte
        or     (ix+008H)
        ld     (ix+008H),a
        ld     a,l                    ; And now the right hand byte
        or     (ix+010H)
        ld     (ix+010H),a
        jr     END18
;       ELSE                        ; Replace background with non-zero bytes
ELSE18:
        or     a                      ; Is byte non-zero
;       IF [PSW,IS,NZERO]

```



```

        jr      z,END19
        ld      (ix+000H),a          ; Yes, then replace background with object
END19:
        ld      a,h                  ; Same for middle
        or      a
        jr      z,END20
        ld      (ix+008H),a
END20:
        ld      a,l                  ; Same for right hand byte
        or      a
        jr      z,END21
        ld      (ix+010H),a
END21:
END18:
PM15:
        bit     7,(iy+FLAGS)         ; Find out which graphics mode used
        ; IF [PSW,IS,ZERO]          ; Then mode 2
        ; [mode 1 colors done after combined loop]
        jr      z,END22
        push    ix                   ; Save background pointer
        ld      bc,BK_CLR-BK_PTN    ; Change IX to point to color generators
        add     ix,bc
        ld      b,(iy+COLR)          ; Get object color
        bit     1,(iy+FLAGS)         ; color0 = background or transparent ?
        ; IF [PSW,IS,ZERO]          ; Then use background color0
        jr      nz,ELSE23
        ld      c,00FH               ; Mask for color0 of background
        jr      END23
        ;
ELSE23:
        ld      c,000H               ; Mask replace color0 with transparent
END23:
        ld      a,e                  ; Get 1st object's pattern byte
        or      a                    ; Are there any '1' bits?
        jr      z,END24
        ld      a,(ix+000H)          ; Get background color gen
        and     c                    ; Mask out color1
        or      b                    ; Add object color1
        ld      (ix+000H),a          ; Update color generator
END24:
        ld      a,h                  ; Same for middle byte
        or      a
        jr      z,END25
        ld      a,(ix+008H)
        and     c
        or      b
        ld      (ix+008H),a
END25:
        ld      a,l                  ; Same for right hand byte
        or      a
        jr      z,END26
        ld      a,(ix+010H)
        and     c
        or      b
        ld      (ix+010H),a
END26:
        pop     ix                   ; Restore background pointer
END22:
        ret

```

## PUT COMPLEX

```

; .IDENT PUTCOMP
; .ZOP
; .EPOP
; .IF1 ,.INSERT B:SPZ80.ASM
; .COMMENT }
;
; 4/15/82
; 10:40:00
;***** PUT_COMPLEX *****
;
;DESCRIPTION: The position and frame number of each of a complex object's
;              component objects is updated. Then put_object is called for
;              each of the component objects.
;
;INPUT:        IX = Address of object to be processed
;              HL = Address of object's graphics tables in ROM
;              B = Selector for methode of combining object generators
;                  with background generators
;              C = Object type, and number of components
;
;-----
;METHODE OF COMBINING OBJECT GENERATORS:
;
;              1 = Object pattern gens ored with background pattern gens
;                  color1 of background changed to mobile object's color
;                  if corresponding pattern byte not zero
;
;              2 = Replace background pattern gens with object pattern gens
;                  treat color same as #1
;
;              3 = Same as #1 except color0 changed to transparent
;
;              4 = Same as #2 except color0 changed to transparent
;
;*****
; }
; EXT PUTOBJ
; GLB PUTCOMPLEX

```

### PUTCOMPLEX:

```

; Update the frame number and the X and Y location in each of the component
; object's status areas
;
; push bc ; Save selector and component count [COMP_CNT]
; exx ; Use primed regs for X_LOC and Y_LOC
; ld h,(ix+003H) ; High-byte of status
; ld l,(ix+002H) ; Low-byte of status
; ld a,(hl) ; A := FRAME
; inc hl
; ld c,(hl) ; BC' := X_LOCATION
; inc hl
; ld b,(hl)
; inc hl
; ld e,(hl) ; DE' := Y_LOCATION
; inc hl
; ld d,(hl)
; exx
; add a,a ; FRAME := 4*FRAME
; add a,a
; ld e,a ; from pointer to frame and offset pointers
; ld d,000H

```

```

        inc    hl                      ; Point to 1st of FRA_OFFSET_PNTR pairs
        add    hl,de                  ; Point to FRAME pointer
        ld     c,(hl)                 ; BC := FRAME pointer
;      [POINTER TO LIST OF FRAME #'s]
        inc    hl
        ld     b,(hl)
        inc    hl
        ld     e,(hl)                 ; DE := Offset pointer [PNTR TO LIST OF OFFSETS]
        inc    hl
        ld     d,(hl)
        ld     h,b
        ld     l,c                     ; HL := FRAME pointer
;
; DE' = Y_LOC, BC' = X_LOC, HL = PNTR to frame list, DE = PNTR to offset list
; IX = Addr of OBJ, [SP] = COMP_CNT & SELECTOR
; FOR N=0 TO COMP_CNT-1: COMP_OBJ[N] FRAME := FRAME#[N] FROM FRAME LIST
;      COMP_OBJ[N] X_LOCATION := CMPLX_OBJ.X_LOCATION + X_OFFSET[N]
;      COMP_OBJ[N] Y_LOCATION := CMPLX_OBJ.Y_LOCATION + Y_OFFSET[N]
;
        pop    bc
        ld     a,c                     ; Get component count into B
        ld     c,b                     ; Save selector in C
        srl    a                       ; Get count into low nibble
        srl    a
        srl    a
        ld     b,a                     ; # := component count
        push   bc                      ; Save counter and selector on stack
        push   ix                      ; Save addr of OBJ
LP1:
        push   hl                      ; Save pntr to frame list
        push   de                      ; Save pntr to offset list
        ld     l,(ix+004H)
        ld     h,(ix+005H)             ; HL := Addr of component OBJ
        inc    ix                      ; Point to next object pointer
        inc    ix
        inc    hl
        inc    hl                      ; HL points to status pointer
        ld     e,(hl)
        inc    hl
        ld     d,(hl)                 ; DE := Addr of status for component object
        push   de
        pop    iy                      ; IY := Addr of status for component object
        pop    de                      ; DE := pntr to offset list
        pop    hl                      ; HL := pntr to frame list
        ld     a,(hl)                 ; Get frame number
        bit    7,(iy+000H)             ; Preserve bit 7 of frame
        jr     z,TBL0                 ; used by mobile objects to indicate which
                                        ; VRAM tables in use.
        set    7,a
TBL0:
        ld     (iy+000H),a             ; Move to components status area
        inc    hl                      ; Point to next frame number
        ld     a,(de)                 ; Get X_Offset
        exx
        ld     l,a
        ld     h,000H                 ; HL' := X_Offset
        add    hl,bc                   ; HL' := X_Offset + X_Location
        ld     (iy+001H),l
        ld     (iy+002H),h             ; Component's X_Location := X_Offset +
X_Location
        exx
        inc    de                     ; Point to Y_Offset

```

```

        ld    a,(de)
        exx
        ld    l,a
        ld    h,000H          ; HL := Y_Offset
        add   hl,de           ; HL := Y_Offset + Y_Location
        ld    (iy+003H),l
        ld    (iy+004H),h     ; Component's Y_Location := Y_Offset +
Y_Location
        exx
        inc   de              ; Point to next offset pair
        djnz  LP1
;
; Call PUT_OBJECT for each of the component objects, pass selector in B
        pop   iy              ; Get object address back
        ld    bc,00004H
        add   iy,bc           ; IY points to pointer to 1st component object
        pop   de              ; DE := Counter and Selector
LP2:
        ld    l,(iy+000H)
        ld    h,(iy+001H)    ; HL := Address of component object
        inc   iy
        inc   iy              ; IY := Points to next component object
pointer
        push  hl
        pop   ix              ; IX := Address of component object
        push  iy              ; Save pointer
        push  de              ; Save counter and selector
        ld    b,e             ; B := Selector
        call  PUTOBJ
        pop   de              ; Get counter and selector
        pop   iy              ; Get address of next component object pointer
        dec   d
        jr    nz,LP2
        ret

```

## TIME MANAGER

```
; ; Ken Lagace and Rob Jepsen 3/82
; #Global
; GLB TIMER_TABLE_BASE          ; Is this necessary ??
; GLB NEXT_TIMER_DATA_BYTE      ; Or this??
;
; #Extern
; EXT PARAM_ ; Parameter passing routine needed
;           ; for setting up pascal interfaces
;
; #Global
; GLB INIT_TIMER_
; GLB INIT_TIMERQ
; GLB FREE_SIGNAL_
; GLB FREE_SIGNALQ
; GLB REQUEST_SIGNAL_
; GLB REQUEST_SIGNALQ
; GLB TEST_SIGNAL_
; GLB TEST_SIGNALQ
; GLB TIME_MGR_
; GLB TIME_MGRQ
;
; #Define
DONE EQU    7
REPEAT EQU   6
FREE EQU     5
EOT EQU      4
LONG EQU     3

;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
;
; . . . . . MODE BIT . . . . .
; TO CHECK BIT ***** BIT ? JR Z = JUMP IF BIT IS 0 !
;
;
;
;
; DONE ; REPEAT ; FREE ; E O T ;; LONG ; -- ; -- ; --
; 7 ; 6 ; 5 ; 4 ;; 3 ; 2 ; 1 ; 0 ;
;
;
TIME_MGRQ:
TIME_MGR_:
    ld hl,(TIMER_TABLE_BASE) ; Current time address
NEXT_TIMER0:
    bit FREE,(hl) ; Free?
    call z,DCR_TIMER ; If not, decrement
    bit EOT,(hl) ; End of table?
    jr nz,SCRAM ; If it is, we're done.
    inc hl ; Otherwise get next timer
    inc hl ; and start over.
    inc hl
    jr NEXT_TIMER0
SCRAM:
    ret
;
DCR_TIMER:
    push hl ; Save current timer.
    bit LONG,(hl) ; Long?
    jr z,DCR_S_MODE_TBL ; Short, non-repeating
    bit REPEAT,(hl) ; Repeat?
    jr nz,DCR_L_RPT_TBL ; Long, repeating
```

```

DCR_L_MODE_TBL:                ; Long non-repeating
    inc    hl
    ld     e, (hl)              ; Move the counter to DE
    inc    hl
    ld     d, (hl)
    dec    de                    ; Decrement.
    ld     a, e
    or     d                    ; Check if 0.
    jr     nz, SAVE_2_BYTES      ; If not save'm.
    pop    hl                    ; Otherwise, get mode byte
    push   hl                    ; and set it's done bit.
    jr     SET_DONE_BIT

;
DCR_L_RPT_TBL:                  ; Long-repeating timer
    inc    hl
    ld     e, (hl)              ; Move the counter to DE
    inc    hl
    ld     d, (hl)
    ex     de, hl                ; Exchange and
    ld     e, (hl)              ; load addr. Into DE
    inc    hl
    ld     d, (hl)
    dec    de                    ; Decrement
    ld     a, e
    or     d                    ; Check for 0.
    jr     nz, SAVE_2_BYTES      ; Save if not.
    inc    hl                    ; Otherwise, reload
    ld     e, (hl)              ; original counter #.
    inc    hl
    ld     d, (hl)              ; jockey all over to
    dec    hl                    ; perform said task!
    dec    hl
    ld     (hl), d
    dec    hl
    ld     (hl), e
    pop    hl
    push   hl
    jr     SET_DONE_BIT ; Then set done bit.

;
DCR_S_MODE_TBL:
    inc    hl
    dec    (hl)
    jr     nz, TIMER_EXIT
    pop    hl
    push   hl
    bit    REPEAT, (hl)          ; Repeat?
    jr     z, SET_DONE_BIT       ; If not, leave.
    inc    hl                    ; Otherwise, jockey
    inc    hl                    ; around again and
    ld     a, (hl)              ; reload original #.
    dec    hl
    ld     (hl), a
    dec    hl
    pop    hl
    push   hl

SET_DONE_BIT:
    set    DONE, (hl)

TIMER_EXIT:
    pop    hl
    ret

;
SAVE_2_BYTES:
    ld     (hl), d

```

```

        dec    hl
        ld     (hl),e
        jr     TIMER_EXIT
;
; Procedure Init Timer
; HL has address of Timer table
; DE has address of Timer Data Table
;
; #Common
; INIT_TIME_DATA:
; TEMP1: DEFS 2
; TEMP2: DEFS 2
;
INIT_TIMER_PARAM:
        dw     00002H
        dw     00002H
        dw     00002H
;
INIT_TIMERQ:
        ld     bc,INIT_TIMER_PARAM
        ld     de,PARAM_AREA
        call   PARAM_
        ld     hl,(PARAM_AREA)
        ld     de,(PARAM_AREA+2)
INIT_TIMER_:
        ld     (TIMER_TABLE_BASE),hl      ; Store given base address
                                           ; for timer table
        ld     (hl),030H                  ; Set first byte in timer table to free
; and last timer
        ex     de,hl
        ld     (NEXT_TIMER_DATA_BYTE),hl ; Store given base address
; for data block
        ret
;
; Procedure Free Signal
; Acc has signal number to be freed
; No output is generated
;
; #Common
; SIGNAL_NUM: DEFS 1
;
FREE_SIG_PARAM:
        dw     00001H
        dw     00001H
;
FREE_SIGNALQ:
        ld     bc,FREE_SIG_PARAM
        ld     de,PARAM_AREA+4
        call   PARAM_
        ld     a,(PARAM_AREA+4)
FREE_SIGNAL_:
        ld     c,a                        ; Put Free code into C register
        ld     hl,(TIMER_TABLE_BASE)     ; Get Timer Base address
        ld     b,a                        ; Timer offset already available
        ld     de,00003H                  ; Setup offset to subsequent timers
        or     a                          ; See if the first timer is requested
        jr     z,FREE_MATCH               ; If so we have a match
                                           ; Otherwise
FREE1:
        bit    EOT,(hl)                  ; Loop to find requested signal
                                           ; Check if end of table
        jr     nz,FREE_EXIT               ; If so go no further
        add    hl,de                      ; If not then offset to next timer
        dec    c                          ; Decrement signal request

```

```

        jr      nz,FREE1          ; If requested signal not zero
; then go try the next
; Else
FREE_MATCH:                          ; Here when the requested signal
; matches current signal
        bit     FREE,(hl)         ; Check if already free
        jr      nz,FREE_SET       ; If so then just reset LONG
        set     FREE,(hl)         ; Set current timer to free
        bit     REPEAT,(hl)       ; Check for repeating timer
        jr      z,FREE_SET        ; If not then go free it
        bit     LONG,(hl)         ; Check also for long timer
        jr      z,FREE_SET        ; If not long then go free it
; call FREE_COUNTER_              ; Else release timer data before freeing it
;
; FREE (DELETE) COUNTER
; KENL 3/82
; NEEDS "TO-DELETE":counter addr.in DE
;
FREE_COUNTER_:
                                ; HL should contain timer to delete addr.
        inc     hl                ; Get next after mode byte
        ld      e,(hl)           ; into DE
        inc     hl
        ld      d,(hl)
        push    de                ; Save them for later.
        ld      hl,(TIMER_TABLE_BASE)
        push    hl                ; Save beginning of table.
NEXT:
        bit     EOT,(hl)          ; End of table?
        jr      nz,MOVE_IT
        bit     FREE,(hl)         ; Free?
        jr      nz,GET_NEXT       ; If so we don't want it
        ld      a,(hl)
        and     048H              ; Repeating and long?
        cp      048H
        jr      nz,GET_NEXT       ; If NOT we don't want it
        inc     hl
        inc     hl
        ld      a,(hl)
        cp      d
        jr      c,GET_NEXT        ; If so we don't want it
        jr      nz,SUBSTRACT_4    ; However, if larger, change it
        dec     hl
        ld      a,(hl)
        cp      e                ; Smaller?
        jr      c,GET_NEXT        ; If so we don't want it
        jr      z,FREE_EXIT       ; Error if equal
        inc     hl                ; Setup HL for SUBSTRACT_4
SUBSTRACT_4:
        ld      d,(hl)
        dec     hl
        ld      e,(hl)
        dec     de                ; Reduce this addr. By 4.
        dec     de
        dec     de
        dec     de
        ld      (hl),e           ; Replace reduced addr.
        inc     hl                ; Back where we got it.
        ld      (hl),d
        jr      GET_NEXT
;
GET_NEXT:
        pop     hl                ; Now we can get next timer.

```



```

        inc    hl
        inc    hl
        inc    hl
        push   hl
        jr     NEXT
;
MOVE_IT:
        ld     b,000H
        or     a                                ; CLEAR CARRY
        pop    hl
        pop    de                                ; Get addr. of timer to delete
        push   hl
        ld     hl,(NEXT_TIMER_DATA_BYTE) ; Find # of bytes
        sbc    hl,de                            ; to move by subtraction
        ld     c,1                                ; Save in counter reg.
        ld     l,e                                ; Copy into HL.
        ld     h,d
        inc    hl                                ; Find source addr.
        inc    hl
        inc    hl
        inc    hl
        ldir                                ; Move it!
        ld     bc,00008H ; Adjust next available by -4 from LDIR dest.
        sbc    hl,bc ; (or -8 from source of LDIR! [saves instrs.]).
        ld     (NEXT_TIMER_DATA_BYTE),hl
        pop    hl
FREE_SET:
        ; RES LONG, (HL) ; Reset repeat bit just in case
FREE_EXIT:
        ret ; Return
;
; Procedure Request Signal
; HL pair has length of timer
; Acc has zero for repeating timer any other value for a non_repeating type
; Signal number is returned in the Accumulator
; #Common
; REPEAT_SIG_CODE: DEFS 1
; TIMER_LENGTH: DEFS 2
REQUEST_SIG_PARAM:
        dw     00002H
        dw     00001H
        dw     00002H
;
REQUEST_SIGNALQ:
        ld     bc,REQUEST_SIG_PARAM
        ld     de,PARAM_AREA+5
        call   PARAM_
        ld     hl,(TIMER_LENGTH)
        ld     a,(PARAM_AREA+5)
REQUEST_SIGNAL_:
        ld     c,a ; Put Repeat Code into C register
        ex     de,hl ; Put length of timer into DE
        ld     hl,(TIMER_TABLE_BASE) ; Get Timer Base Address
        xor    a ; Into offset to First Table value
        ld     b,a
TIMER1:
        bit    FREE,(hl) ; See if current timer free
        jr     z,NEXT_TIMER1 ; If not go get the next timer
        push   hl
        ld     a,(hl)
        and    010H
        or     020H
        ld     (hl),a

```

```

        xor    a
        or     d
        jr     nz, LONG_TIMER
        ; RES FREE, [HL]          ; Reset free bit
        ; OR D                    ; Check for zero
        ; JR NZ, LONG_TIMER; If non_zero then it's a long timer
        ; RES REPEAT, [HL]        ; Set for a NON_Repeating timer
        ; RES LONG, [HL]
        ; LD A, C                  ; Check for a short repeating timer
        or     c
        jr     z, NOT_A_REPEAT_TIMER ; Don't reset repeat bit in mode byte
        ; if non_repeating
        set    REPEAT, (hl)        ; Set repeat bit
NOT_A_REPEAT_TIMER:
        inc    hl                  ; Go to next table location
        ld     (hl), e             ; Store timer length
        inc    hl
        ld     (hl), e             ; Store timer length again in case of repeat
        jr     INIT_TIMER_EXIT     ; All done so let's exit
;
LONG_TIMER:
        set    LONG, (hl)          ; Set long timer bit
        ld     a, c                ; Check for a long repeat timer
        or     a
        jr     z, NOT_A_LONG_REPEAT ; If zero then go to non_repeating timer
        push   de                  ; Store timer length temporary
        ex     de, hl              ; Swap registers
        ld     hl, (NEXT_TIMER_DATA_BYTE) ; To get free space
        ; in long timer table
        ex     de, hl              ; Then swap back
        set    REPEAT, (hl)        ; Set mode byte to repeating
        inc    hl
        ld     (hl), e             ; Store low-byte of timer address
        ; into the value word
        inc    hl
        ld     (hl), d             ; Store high-byte of timer address
        ex     de, hl              ; Move address of data area into HL
        pop    de                  ; Get back the length of timer
        ld     (hl), e             ; Store that in the data table
        inc    hl
        ld     (hl), d
        inc    hl
        ld     (hl), e             ; Store it again
        inc    hl
        ld     (hl), d
        inc    hl
        ld     (NEXT_TIMER_DATA_BYTE), hl ; Store the next available data area
        ; for future use
        jr     INIT_TIMER_EXIT
;
NOT_A_LONG_REPEAT:
        inc    hl
TIMER2:
        ld     (hl), e             ; Store it again
        inc    hl
        ld     (hl), d
        inc    hl
        jr     INIT_TIMER_EXIT
;
NEXT_TIMER1:
        bit    EOT, (hl)
        jr     nz, MAKE_NEW_TIMER
        inc    hl                  ; Go to next mode byte

```

```

        inc    hl
        inc    hl
        inc    b                ; Count to next offset
        jr     TIMER1          ; Go back up to init. timer
;
MAKE_NEW_TIMER:                ; Maximum of 255 signals allowed
    push    de                ; Save DE for a work register
    push    hl                ; Save current timer address
    inc     hl                ; Go to next available memory location
    inc     hl                ; in the Timer Table
    inc     hl
    inc     b
    ld      (hl),030H
    ex      de,hl             ; Save momentarily
    pop     hl                ; Get back original timer
    res     EOT,(hl)          ; Reset previous last timer
    ex      de,hl             ; Get back current last timer
    pop     de                ; Restore DE register
    jr     TIMER1            ; Go back up and initialize counter for use
;
INIT_TIMER_EXIT:
    pop     hl
    res     FREE,(hl)
    ld      a,b                ; Put the offset into the Accumulator
; for the user of routine
    ret
;
; Procedure Test Signal
; Acc has the Signal number to be tested
; A value of True(1) or False(0) is returned in the Accumulator for the
;     Signal given.
;
; #Common
; TEST_SIG_NUM:      DEFS    1
TEST_SIG_PARAM:
    dw      00001H
    dw      00001H
;
TEST_SIGNALQ:
    ld      bc,TEST_SIG_PARAM
    ld      de,TEST_SIG_NUM
    call    PARAM_
    ld      a,(TEST_SIG_NUM)
TEST_SIGNAL_:
    ld      c,a                ; Put Signal Code into C register
    ld      hl,(TIMER_TABLE_BASE) ; Get Timer Base Address
    ld      b,a                ; Save Signal
    ld      de,00003H          ; Setup offset for next timer
    or      a                  ; See if first timer is a match
    jr      z,SIGNAL_MATCH     ; If so go check it
TEST1:
    bit     EOT,(hl)           ; Loop to match timer table to desired timer
                                ; Check for end of table
    jr      nz,SIGNAL_FALSE    ; If so then return a not done
    add     hl,de               ; Now index to next timer
    dec     c                  ; Decrement to the timer desired
    jr      nz,TEST1           ; If not a timer desired timer then go back
SIGNAL_MATCH:                  ; Here with a timer match
    bit     FREE,(hl)
    jr      nz,SIGNAL_FALSE
    bit     DONE,(hl)          ; Check for timer done
    jr      nz,SIGNAL_TRUE     ; If so then go return a True
SIGNAL_FALSE:                  ; Here to return a false for either
                                ; a not done or non_existent timer

```

```

        xor    a                ; Put a false in Acc
        jr     TEST_EXIT       ; Got to the exit
;
SIGNAL_TRUE:                ; Here when timer is finished
        bit    REPEAT, (hl)    ; Check for repeating timer
        jr     nz, SIGNAL_TRUE1 ; If so then just return True
        set    FREE, (hl)      ; Free current timer since not repeating
SIGNAL_TRUE1:
                                ; ***** Start add 4/30/82*****
        res    DONE, (hl)      ; Reset current timer to not done
                                ; ***** End add 4/30/82*****
        ld     a, 001H         ; Put a true in the Acc
TEST_EXIT:                  ; Return
        or     a
        ret

```

## CONTROLLER SOFTWARE

```

;
; #Defines
NUM_DEV      EQU    005H
KDB_NULL     EQU    00FH
CONTROLLER_0 EQU    000H
STROBE_SET   EQU    001H
FIRE_MASK    EQU    040H
JOY_MASK     EQU    00FH
ARM_MASK     EQU    040H
KBD_MASK     EQU    00FH
PLYR_0       EQU    00002H
PLYR_1       EQU    00007H
SEG_0        EQU    007H
SEG_1        EQU    018H
FIRE         EQU    000H
JOY          EQU    001H
SPIN         EQU    002H
ARM          EQU    003H
KBD          EQU    004H
FIRE_OLD     EQU    000H
FIRE_STATE   EQU    001H
JOY_OLD      EQU    002H
JOY_STATE    EQU    003H
SPIN_OLD     EQU    004H
SPIN_STATE   EQU    005H
ARM_OLD      EQU    006H
ARM_STATE    EQU    007H
KBD_OLD      EQU    008H
KBD_STATE    EQU    009H
;
; #Defines (PORTS)
STRB_RST_PORT EQU    0C0H
STRB_SET_PORT EQU    080H
CTRL_0_PORT   EQU    0FCH
CTRL_1_PORT   EQU    0FFH
;
; #Global
; GLB  CONTROLLER_INIT      ; Initialize controller to strobe reset
; GLB  CONT_READ            ; Controller read routine
; GLB  CONT_SCAN            ; Controller scanner routine
; GLB  UPDATE_SPINNER_      ; Update spinner switch routine
; GLB  DECODER_             ; Decodes raw, undebounced data
; GLB  POLLER_              ; Polling routine for all devices in controller

; Decoder table for keyboard (keypad)
DEC_KBD_TBL:
    db    KDB_NULL
    db    006H    ; '6'
    db    001H    ; '1'
    db    003H    ; '3'
    db    009H    ; '9'
    db    000H    ; '0'
    db    00AH    ; '*'
    db    KDB_NULL
    db    002H    ; '2'
    db    00BH    ; '#' (RESET)
    db    007H    ; '7'
    db    KDB_NULL
    db    005H    ; '5'

```

```

        db      004H   ; '4'
        db      008H   ; '8'
        db      KDB_NULL
;
CONTROLLER_INIT:
; Initialize controller to strobe reset
        out     (STRB_RST_PORT),a
        xor     a
        ld      ix,(CONTROLLER_MAP)
        inc     ix
        inc     ix
        ld      iy,DBNCE_BUFF
        ld      b,NUM_DEV*2
CINIT1:
        ; Clear controller memory and debounce status buffer
        ld      (ix+000H),a
        inc     ix
        ld      (iy+000H),a
        inc     iy
        ld      (iy+000H),a
        inc     iy
        dec     b
        jr      nz,CINIT1
        ; Clear remaining variables
        ld      (SPIN_SW0_CT),a
        ld      (SPIN_SW1_CT),a
        ld      (S0_C0),a
        ld      (S0_C1),a
        ld      (S1_C0),a
        ld      (S1_C1),a
        ret
;
DELAY:
        ; Delay after strobe, before read
        nop
        ret
;
; Controller read routine
; Input: H - Controller number
; Output: A - Raw data
CONT_READ:
        ld      a,h
        cp      CONTROLLER_0 ; If controller<>0
        jr      nz,CONT_READ1; then read player 1
        in      a,(CTRL_0_PORT) ; else read player 0
        jr      CONT_READX
;
CONT_READ1:
        in      a,(CTRL_1_PORT)
CONT_READX:
        cpl
        ret ; complement data so 0=no data, 1=data
;
; Controller scanner routine
CONT_SCAN:
        in      a,(CTRL_0_PORT) ; Read segment 0, both players
        cpl
        ld      (S0_C0),a
        in      a,(CTRL_1_PORT)
        cpl
        ld      (S0_C1),a
        out     (STRB_SET_PORT),a ; Strobe segment 1
        call    DELAY ; wait 10 microsecs

```

```

        in    a, (CTRL_0_PORT)      ; Read segment 1, both players
        cpl
        ld    (S1_C0), a
        in    a, (CTRL_1_PORT)
        cpl
        ld    (S1_C1), a
        out   (STRB_RST_PORT), a    ; Reset to segment 0
        ret

;
; Update spinner switch routine
UPDATE_SPINNER_:
        in    a, (CTRL_0_PORT)      ; Get data
        ld    hl, SPIN_SW0_CT       ; address of spinner 0 count
        bit   4, a                  ; If int bit set
        jr    nz, UPDATE_S1 ; Then spinner 1
UPDATE_S0:
        bit   5, a                  ; If bit 5 is set
        jr    nz, UPDATE_R0 ; Then going right
                                ; Else left
        dec   (hl)                  ; Decrement spinner counter
        jr    UPDATE_S1             ; Go check spinner 1
;
UPDATE_R0:
        inc   (hl)                  ; Right, spinner increment counter
UPDATE_S1:
        in    a, (CTRL_1_PORT)      ; Look at spinner 1 data
        bit   4, a                  ; If int bit set
        jr    nz, UPDATE_SPINX      ; Then not spinner 1
        inc   hl                    ; Else spinner 1, bump HL
; Check direction
        bit   5, a                  ; If bit 5 is set
        jr    nz, UPDATE_R1 ; Then going right
                                ; Else left
        dec   (hl)                  ; Decrement spinner counter
        jr    UPDATE_SPINX
;
UPDATE_R1:
        inc   (hl)                  ; Right, increment spinner counter
UPDATE_SPINX:
        ret
;
; Decoder routine
; Desc.: This routine returns decoded raw, undebounced data
;        and may or not be required by O/S
;
; Input: H - Controller number
;        L - Segment number
;
; Output:
;
;          SEGMENT 0      SEGMENT 1
;          H - BYTE 1 FIRE      ARM
;          L - BYTE 2 JOYSTICK   KBD
;          E - BYTE 3 SPINNER
;
DECODER_:
        ld    a, 1
        cp    STROBE_SET           ; If L=1 then decode segment 1
        jr    z, DEC_SEG1
; Segment 0 (FIRE BUTTON, JOYSTICK)
; Return H=FIRE BUTTON, L=JOYSTICK, E=SPINNER
; Do spinner first
        ld    bc, SPIN_SW0_CT
        ld    a, h
        cp    CONTROLLER_0 ; If player=0 then go decode

```

```

        jr      z,DEC_PLYR
        inc     bc                      ; Else increment BC to spinner 1
DEC_PLYR:
        ld      a,(bc)                 ; Get spinner switch count
        ld      e,a                   ; Return it in E
        xor     a
        ld      (bc),a                 ; Clear out device data for player
        call    CONT_READ              ; Get other device data for player
        ld      d,a                   ; Save it
        and     JOY_MASK               ; Mask out joystick data
        ld      l,a                   ; Return it in L
        ld      a,d                   ; Restore data
        and     FIRE_MASK             ; Mask out fire button data
        ld      h,a                   ; Return it in H
        jr      DECODERX
;
; Segment 1 (ARM BUTTON, KEYBOARD)
; Return H=ARM BUTTON, L=KEYBOARD
DEC_SEG1:
        out     (STRB_SET_PORT),a     ; Strobe segment 1
        call    CONT_READ              ; Read segment 1 player data
        ld      d,a                   ; Save it
        out     (STRB_RST_PORT),a     ; Reset back to segment 0
        and     KBD_MASK              ; Mask out keyboard data
        ld      hl,DEC_KBD_TBL        ; Get decoder table address
        ld      b,000H
        ld      c,a
        add     hl,bc                  ; Compute offset
        ld      l,(hl)                ; Return keyboard data in L
        ld      a,d                   ; Restore data
        and     ARM_MASK              ; Mask out ARM button data
        ld      h,a                   ; Return it in H
DECODERX:
        ret
;
; Polling routine for all devices in controller
POLLER_:
        call    CONT_SCAN              ; Go scan all data first
        ld      iy,DBNCE_BUFF         ; Debounce buffer pointer
        ld      ix,(CONTROLLER_MAP)   ; controller memory pointer
        push    ix
        ld      a,(ix+000H)            ; Get player 0 status
        bit     7,a                   ; If player 0 is not active
        jr      z,CHK_PLYR_1          ; Then check player 1
        ; Else (player 0 is active)
        ld      b,a                   ; Save status
        ld      de,PLYR_0             ; Compute address for player 0
        add     ix,de                 ; CONTROLLER_MEMORY
        and     SEG_0                 ; If segment 0 is not active
        jr      z,CHK_SEG_01          ; Then check segment 1
        ; Else (segment 0 is active)
        ld      a,(S0_C0)
        ld      hl,SPIN_SW0_CT
        call    DECODE_0              ; Decode data for segment 0
CHK_SEG_01:
        ld      a,b                   ; Restore player 0 status
        and     SEG_1                 ; If segment 1 is not active
        jr      z,CHK_PLYR_1          ; Then check player 1
        ; Else (segment 1 is active)
        ld      a,(S1_C0)
        call    DECODE_1              ; Decode data for segment 1
CHK_PLYR_1:
        pop     ix

```



```

        ld      a,(ix+001H)          ; Get Player 1 status
        bit     7,a                  ; If player 1 is not active
        jr      z,POLLER_X          ; Then exit all done
                                      ; Else (player 1 is active)
        ld      b,a                  ; Save player 1 status
        ld      de,2*NUM_DEV        ; Compute address of debounce buffer
        add     iy,de                ; for player 1
        ld      de,PLYR_1          ; Compute address of CONTROLLER_MEMORY
        add     ix,de                ; for player 1
        and     SEG_0               ; If segment 0 is not active
        jr      z,CHK_SEG_11        ; Then check segment 1
        ld      a,(S0_C1)
        ld      hl,SPIN_SW1_CT
        call    DECODE_0            ; Decode data for segment 1
CHK_SEG_11:
        ld      a,b                  ; Restore status for player 1
        and     SEG_1               ; If segment 1 is not active
        jr      z,POLLER_X          ; Then exit, all done
                                      ; Else (segment 1 is active)
        ld      a,(S1_C1)
        call    DECODE_1            ; Decode data for segment 1
POLLER_X:
        ret

;
; Decode routine for segment 0
; Input: A - Data
;         B - Device status byte for current player
;         HL - Address of spinner data
;         IX - Pointer to controller memory
;         IY - Pointer to debounce status buffer
DECODE_0:
        ld      c,a                  ; Save data
        bit     JOY,b                ; If joystick not active
        jr      z,DEC_FIRE          ; Then check fire button
                                      ; Else joystick active
        call    JOY_DBNCE           ; Debounce joystick data
        ld      a,c
DEC_FIRE:
        bit     FIRE,b               ; If fire button is not active
        jr      z,DEC_SPIN          ; Then check spinner
                                      ; Else (fire button active)
        call    FIRE_DBNCE          ; Debounce fire button
        ld      a,c
DEC_SPIN:
        bit     SPIN,b               ; If spinner is not active
        jr      z,DECODE_0X         ; Then exit decoder
                                      ; Else (spinner active)
        ld      a,(hl)               ; Save spinner count
        add     a,(ix+SPIN)
        ld      (ix+SPIN),a         ; in controller memory
        xor     a
        ld      (hl),a              ; Clear counter
DECODE_0X:
        ret

;
; Decoder routine for segment 1
; Input: A - Data
;         B - Device status byte for current player
;         IX - Pointer to controller memory
;         IY - Pointer to debounce status buffer
DECODE_1:
        ld      c,a                  ; Save data
        bit     ARM,b                ; If ARM button not active

```

```

        jr      z,DEC_KBD          ; Then check keyboard
                                   ; Else (ARM button active)
        call    ARM_DBNCE          ; Debounce ARM button
        ld      a,c
DEC_KBD:
        bit     KBD,b              ; If keyboard not active
        jr      z,DECODE_1X        ; Then exit decoder
                                   ; Else keyboard active
        call    KBD_DBNCE          ; Debounce keyboard
DECODE_1X:
        ret
;
; Keyboard debounce routine
; Input: A - Raw data
;         IX - Controller memory pointer
;         IY - Debounce status buffer
KBD_DBNCE:
        push    bc
        push    de
        push    hl
        and     KBD_MASK           ; Mask out valid data
        ld      e,a               ; and save it
        ld      b,(iy+KBD_OLD)     ; Get old data
        ld      a,(iy+KBD_STATE)   ; and current status
        cp      000H              ; If state<>0
        jr      nz,KBD_ST1         ; Then must be state=1
KBD_ST0:
        ld      a,e               ; Get current data
        cp      b                 ; If old=new
        jr      z,KBD_REG          ; Then saw data twice in sequence
        ld      (iy+KBD_OLD),e     ; Else first time, save current data
        jr      KBD_EXIT
;
KBD_REG:
        ld      a,001H             ; Set state=1
        ld      (iy+KBD_STATE),a
        ld      hl,DEC_KBD_TBL     ; Decode table address
        ld      d,000H             ; D/E raw data
        add     hl,de              ; Compute address into table
        ld      a,(hl)             ; Do table lookup
        ld      (ix+KBD),a         ; Save in controller memory 2kdb
        jr      KBD_EXIT
;
KBD_ST1:
        ld      a,e               ; Get current data
        cp      b                 ; If old=new
        jr      z,KBD_EXIT         ; No change in state
        ld      (iy+KBD_OLD),e     ; Else save current data
        xor     a                 ; Set state=0
        ld      (iy+KBD_STATE),a
KBD_EXIT:
        pop     hl
        pop     de
        pop     bc
        ret
;
; Fire debounce routine
; Input: A - Raw data
;         IX - Controller memory pointer
;         IY - Debounce status buffer
FIRE_DBNCE:
        push    bc
        push    de

```

```

        and    FIRE_MASK          ; Mask out valid data
        ld     e,a                ; and save it
        ld     b,(iy+FIRE_OLD)    ; Get old data
        ld     a,(iy+FIRE_STATE)  ; and current status
        cp     000H              ; If state<>0
        jr     nz,FIRE_ST1        ; Then must be state=1
FIRE_ST0:                                ; Else (state=0)
        ld     a,e                ; Get current data
        cp     b                  ; If old=new
        jr     z,FIRE_REG         ; Then saw data twice in sequence
        ld     (iy+FIRE_OLD),e    ; Else first time, save current data
        jr     FIRE_EXIT

;
FIRE_REG:
        ld     a,001H            ; Set state=1
        ld     (iy+FIRE_STATE),a
        ld     (ix+FIRE),e        ; Save in controller memory 2fire
        jr     FIRE_EXIT

;
FIRE_ST1:
        ld     a,e                ; Get current data
        cp     b                  ; If old=new
        jr     z,FIRE_EXIT        ; No change in state
        ld     (iy+FIRE_OLD),e    ; Else save current data
        xor    a                  ; Set state=0
        ld     (iy+FIRE_STATE),a
FIRE_EXIT:
        pop    de
        pop    bc
        ret

;
; Joystick debounce routine
; Input: A - Raw data
;         IX - Controller memory pointer
;         IY - Debounce status buffer
JOY_DBNCE:
        push   bc
        push   de
        and    JOY_MASK          ; Mask out valid data
        ld     e,a                ; and save it
        ld     b,(iy+JOY_OLD)    ; Get old data
        ld     a,(iy+JOY_STATE)  ; and current status
        cp     000H              ; If state<>0
        jr     nz,JOY_ST1        ; Then must be state=1
JOY_ST0:                                ; Else (state=0)
        ld     a,e                ; Get current data
        cp     b                  ; If old=new
        jr     z,JOY_REG         ; Then saw data twice in sequence
        ld     (iy+JOY_OLD),e    ; Else first time, save current data
        jr     JOY_EXIT

;
JOY_REG:
        ld     a,001H            ; Set state=1
        ld     (iy+JOY_STATE),a
        ld     (ix+JOY),e        ; Save in controller memory 2joy
        jr     JOY_EXIT

;
JOY_ST1:
        ld     a,e                ; Get current data
        cp     b                  ; If old=new
        jr     z,JOY_EXIT        ; No change in state
        ld     (iy+JOY_OLD),e    ; Else save current data
        xor    a                  ; Set state=0

```

```

        ld      (iy+JOY_STATE),a
JOY_EXIT:
        pop     de
        pop     bc
        ret

;
; ARM button debounce routine
; Input: A - Raw data
;       IX - Controller memory pointer
;       IY - Debounce status buffer
ARM_DBNCE:
        push    bc
        push    de
        and     ARM_MASK           ; Mask out valid data
        ld      e,a               ; and save it
        ld      b,(iy+ARM_OLD)     ; Get old data
        ld      a,(iy+ARM_STATE)   ; and current status
        cp      000H              ; If state<>0
        jr      nz,ARM_ST1         ; Then must be state=1
ARM_ST0:
        ld      a,e               ; Else (state=0)
        ld      a,e               ; Get current data
        cp      b                 ; If old=new
        jr      z,ARM_REG          ; Then saw data twice in sequence
        ld      (iy+ARM_OLD),e     ; Else first time, save current data
        jr      ARM_EXIT

;
ARM_REG:
        ld      a,001H            ; Set state=1
        ld      (iy+ARM_STATE),a
        ld      (ix+ARM),e        ; Save in controller memory 2joy
        jr      ARM_EXIT

;
ARM_ST1:
        ld      a,e               ; Get current data
        cp      b                 ; If old=new
        jr      z,ARM_EXIT        ; No change in state
        ld      (iy+ARM_OLD),e    ; Else save current data
        xor     a                 ; Set state=0
        ld      (iy+ARM_STATE),a
ARM_EXIT:
        pop     de
        pop     bc
        ret

```

## DISPLAY LOGO

```
; Description:
; Displays the Coleco logo screen with COLECOVISION on a
; black background. The game title, manufacturer, and
; copyright year are obtained from the cartridge and
; overlayed onto the logo screen. The logo is then
; displayed for 10 seconds after which time a jump to
; the game start address is executed.
;
; If no cartridge is present a default message is
; displayed, instructing the operator to:
;
;     "TURN GAME OFF"
;     "BEFORE INSERTING CARTRIDGE"
;     "OR EXPANSION MODULE."
;     "© 1982 COLECO"
;
; This message is displayed for 60 seconds, the screen
; is then blanked and finally a soft halt is executed
; locking up the program until the unit is reset.
;
; DISPLAY_LOGO exists with the VDP in mode 1, the screen
; blanked, and the ASCII character set in VRAM.
;
; The memory map is as follows:
;
;           VDP MEMORY MAP
;   3800H-3FFFH  SPRITE GENERATOR TABLE
;   2000H-201FH  PATTERN COLOR TABLE
;   1B00H-1B7FH  SPRITE ATTRIBUTE TABLE
;   1800H-1AFFH  PATTERN NAME TABLE
;   0000H-17FFH  PATTERN GENERATOR TABLE
;
; #External
; EXT  PUT_VRAM
; EXT  GAME_NAME
; EXT  WRITE_REGISTER
; EXT  COLORTABLE
; EXT  START_GAME
;
; #Define
DATA_PORT  EQU  0BEH
CTRL_PORT  EQU  0BFH
CARTRIDGE  EQU  08000H
;
; #Global
; GLB  ASCII_TBL      ; Pointer to uppercase ASCII generators
; GLB  NUMBER_TBL     ; Pointer to 0-9 generators
; GLB  DISPLAY_LOGO   ; Display COLECOVISION logo
; GLB  LOAD_ASCII_    ; Load PATTERN_GEN_TABLE with full ASCII set
; GLB  FILL_VRAM_     ; Fill VRAM with a value
; GLB  MODE_1_        ; Set up MODE_1 graphics
;
;
; DISPLAY_LOGO:
;     ld      hl,00000H
```

```

        ld    de,04000H
        ld    a,000H
        call  FILL_VRAM_
        call  MODE_1_
        call  LOAD_ASCII_
        ld    hl,OBJ_TABLE
        ld    de,00060H
WRITE_LOOP:
        push  hl
        push  de
        ld    a,(hl)
        cp    0FFH
        jr    z,DONE_LOGO
        ld    b,a
        inc   b
        ld    hl,LOGO_GEN
        ld    de,00008H
ADDR_ADJ:
        djnz  ADD_8
        pop   de
        push  de
        ld    iy,00001H
        ld    a,003H
        call  PUT_VRAM
        pop   de
        pop   hl
        inc   de
        inc   hl
        jr    WRITE_LOOP
;
DONE_LOGO:
        pop   de
        pop   hl
        jr    WRITE_NAMES
;
ADD_8:
        add   hl,de
        jr    ADDR_ADJ
;
WRITE_NAMES:
        ld    hl,LOGO_NAMES
        ld    de,00085H
        ld    iy,00016H
        ld    a,002H
        call  PUT_VRAM
        ld    hl,LOGO_NAMES+22
        ld    de,000A5H
        ld    iy,00016H
        ld    a,002H
        call  PUT_VRAM
        ld    hl,TRADEMARK
        ld    de,0009BH
        ld    iy,00002H
        ld    a,002H
        call  PUT_VRAM
; SET UP DEFAULT COPYRIGHT MESSAGE
        ld    hl,S_C_1982_COLECO
        ld    de,002AAH
        ld    iy,0000DH
        ld    a,002H
        call  PUT_VRAM
; WRITE OUT COLOR_NAME_TABLE
        ld    hl,LOGO_COLORS

```

```

        ld    de,00000H
        ld    a,004H
        ld    iy,00012H
        call  PUT_VRAM
; ENABLE DISPLAY
        ld    b,001H
        ld    c,0C0H
        call  WRITE_REGISTER
; CARTRIDGE TEST
        ld    hl,CARTRIDGE
        ld    a,(hl)
        cp    0AAH
        jr    nz,NO_CARTRIDGE
        inc   hl
        ld    a,(hl)
        cp    055H
        jr    nz,NO_CARTRIDGE
; CARTRIDGE PRESENT
; DISPLAY GAME TITLE
        ld    hl,GAME_NAME
        call  PARSE
        ld    de,GAME_NAME
        ld    hl,00201H
        call  CENTER_PRT
; DISPLAY COMPANY NAME:
        ld    hl,GAME_NAME
        call  PARSE
        inc   hl
        ld    d,h
        ld    e,l
        call  PARSE
        ld    hl,L01C1
        call  CENTER_PRT
; CHANGE DATE
        ld    hl,GAME_NAME
        call  PARSE
        inc   hl
        call  PARSE
        inc   hl
        ld    de,002ACH
        ld    iy,00004H
        ld    a,002H
        call  PUT_VRAM
; DISPLAY 10 SECONDS
        call  DELAY_10
; TURN OFF DISPLAY
        ld    b,001H
        ld    c,080H
        call  WRITE_REGISTER
        ld    hl,(START_GAME)
        jp    (hl)          ;INFO: index jump
;
NO_CARTRIDGE:
        ld    hl,S_TURN_GAME_OFF
        ld    de,001AAH
        ld    iy,0000DH
        ld    a,002H
        call  PUT_VRAM
        ld    hl,S_BEFORE_INSERTING_CARTRIDGE
        ld    de,001E4H
        ld    iy,0001AH
        ld    a,002H
        call  PUT_VRAM

```

```

        ld      hl,S_OR_EXPANSION_MODULE
        ld      de,00227H
        ld      iy,00014H
        ld      a,002H
        call    PUT_VRAM
; DISPLAY 60 SECONDS
        ld      hl,08A00H
        call    TIMER_1
; TURN OFF DISPLAY
        ld      b,001H
        ld      c,080H
        call    WRITE_REGISTER
SOFT_HALT:
        jr      SOFT_HALT

;
; *****
; *
; *      DATA TABLES      *
; *
; *****
;
; **** COLOR_NAME_TABLE ****
LOGO_COLORS:
        db      000H, 000H, 000H, 0F0H, 0F0H, 0F0H,      0F0H, 0F0H
        db      0F0H, 0F0H, 0F0H, 0F0H, 0F0H, 0D0H, 080H, 090H, 0B0H
        db      030H, 040H
; **** PATTERN_NAME_TABLE ****
LOGO_NAMES:
        db      060H, 061H, 068H, 069H, 070H, 071H, 078H, 079H, 080H, 081H, 088H
        db      089H, 064H, 065H, 06CH, 074H, 075H, 07CH, 084H, 085H, 08CH, 08DH
        db      062H, 063H, 06AH, 06BH, 072H, 073H, 07AH, 07BH, 082H, 083H, 08AH
        db      08BH, 066H, 067H, 06DH, 076H, 077H, 07DH, 086H, 087H, 08EH, 08FH
S_TURN_GAME_OFF:
        db      "TURN GAME OFF"
S_BEFORE_INSERTING_CARTRIDGE:
        db      "BEFORE INSERTING CARTRIDGE"
S_OR_EXPANSION_MODULE:
        db      "OR EXPANSION MODULE."
S_C_1982_COLECO:
        db      01DH, " 1982 COLECO" ; 01DH = COPYRIGHT
TRADEMARK:
        db      01EH, 01FH
; **** PATTERN_GENERATOR_TABLES ****
LOGO_GEN:
        db      000H, 000H, 000H, 000H, 000H, 000H, 000H, 000H
        db      03FH, 07FH, 0FFH, 0FFH, 0F3H, 0F3H, 0F0H, 0F0H
        db      000H, 080H, 0C0H, 0C0H, 0C0H, 0C0H, 000H, 000H
        db      03FH, 07FH, 0FFH, 0FFH, 0F3H, 0F3H, 0F3H, 0F3H
        db      000H, 080H, 0C0H, 0C0H, 0C0H, 0C0H, 0C0H, 0C0H
        db      0F0H, 0F0H, 0F0H, 0F0H, 0F0H, 0F0H, 0F0H, 0F0H
        db      0FFH, 0FFH, 0FFH, 0F0H, 0F0H, 0FFH, 0FFH, 0FFH
        db      0C0H, 0C0H, 0C0H, 000H, 000H, 000H, 000H, 000H
        db      0F1H, 0F1H, 0F1H, 07BH, 07BH, 07BH, 03FH, 03FH
        db      0E0H, 0E0H, 0E0H, 0C0H, 0C0H, 0C0H, 080H, 080H
        db      01FH, 03FH, 07FH, 079H, 078H, 07FH, 07FH, 03FH
        db      080H, 0C0H, 0E0H, 0E0H, 000H, 080H, 0C0H, 0E0H
        db      0F3H, 0F3H, 0FBH, 0FBH, 0FBH, 0FFH, 0FFH, 0FFH
        db      0C0H, 0C0H, 0C0H, 0C0H, 0C0H, 0C0H, 0C0H, 0C0H
        db      0F3H, 0F3H, 0FFH, 0FFH, 07FH, 03FH, 000H, 000H
        db      0C0H, 0C0H, 0C0H, 0C0H, 080H, 000H, 000H, 000H
        db      0F0H, 0F0H, 0FFH, 0FFH, 0FFH, 0FFH, 000H, 000H
        db      000H, 000H, 0C0H, 0C0H, 0C0H, 0C0H, 000H, 000H
        db      03FH, 01FH, 01FH, 01FH, 00EH, 00EH, 000H, 000H

```



```

db      080H, 000H, 000H, 000H, 000H, 000H, 000H, 000H
db      0F0H, 0F0H, 0F0H, 0F0H, 0F0H, 0F0H, 000H, 000H
db      01FH, 001H, 079H, 07FH, 03FH, 01FH, 000H, 000H
db      0E0H, 0E0H, 0E0H, 0E0H, 0C0H, 080H, 000H, 000H
db      0FFH, 0F7H, 0F7H, 0F7H, 0F3H, 0F3H, 000H, 000H
db      0C0H, 0C0H, 0C0H, 0C0H, 0C0H, 0C0H, 000H, 000H
ASC_TABLE:
db      07EH, 081H, 0BDH, 0A1H, 0A1H, 0BDH, 081H, 07EH ; ©
db      01FH, 004H, 004H, 004H, 000H, 000H, 000H, 000H ; t (trade)
db      044H, 06CH, 054H, 054H, 000H, 000H, 000H, 000H ; m (mark)
SPACE:
db      000H, 000H, 000H, 000H, 000H, 000H, 000H, 000H ; (space)
db      020H, 020H, 020H, 020H, 020H, 000H, 020H, 000H ; !
db      050H, 050H, 050H, 000H, 000H, 000H, 000H, 000H ; "
db      050H, 050H, 0F8H, 050H, 0F8H, 050H, 050H, 000H ; #
db      020H, 078H, 0A0H, 070H, 028H, 0F0H, 020H, 000H ; $
db      0C0H, 0C8H, 010H, 020H, 040H, 098H, 018H, 000H ; %
db      040H, 0A0H, 0A0H, 040H, 0A8H, 090H, 068H, 000H ; &
db      020H, 020H, 020H, 000H, 000H, 000H, 000H, 000H ; '
db      020H, 040H, 080H, 080H, 080H, 040H, 020H, 000H ; (
db      020H, 010H, 008H, 008H, 008H, 010H, 020H, 000H ; )
db      020H, 0A8H, 070H, 020H, 070H, 0A8H, 020H, 000H ; *
db      000H, 020H, 020H, 0F8H, 020H, 020H, 000H, 000H ; +
db      000H, 000H, 000H, 000H, 020H, 020H, 040H, 000H ; ,
db      000H, 000H, 000H, 000H, 0F8H, 000H, 000H, 000H ; -
db      000H, 000H, 000H, 000H, 000H, 000H, 020H, 000H ; .
db      000H, 008H, 010H, 020H, 040H, 080H, 000H, 000H ; /
NUMBER_TBL:
db      070H, 088H, 098H, 0A8H, 0C8H, 088H, 070H, 000H ; 0
db      020H, 060H, 020H, 020H, 020H, 020H, 070H, 000H ; 1
db      070H, 088H, 008H, 030H, 040H, 080H, 0F8H, 000H ; 2
db      0F8H, 008H, 010H, 030H, 008H, 088H, 070H, 000H ; 3
db      010H, 030H, 050H, 090H, 0F8H, 010H, 010H, 000H ; 4
db      0F8H, 080H, 0F0H, 008H, 008H, 088H, 070H, 000H ; 5
db      038H, 040H, 080H, 0F0H, 088H, 088H, 070H, 000H ; 6
db      0F8H, 008H, 010H, 020H, 040H, 040H, 040H, 000H ; 7
db      070H, 088H, 088H, 070H, 088H, 088H, 070H, 000H ; 8
db      070H, 088H, 088H, 078H, 008H, 010H, 0E0H, 000H ; 9
db      000H, 000H, 020H, 000H, 020H, 000H, 000H, 000H ; :
db      000H, 000H, 020H, 000H, 020H, 020H, 040H, 000H ; ;
db      010H, 020H, 040H, 080H, 040H, 020H, 010H, 000H ; <
db      000H, 000H, 0F8H, 000H, 0F8H, 000H, 000H, 000H ; =
db      040H, 020H, 010H, 008H, 010H, 020H, 040H, 000H ; >
db      070H, 088H, 010H, 020H, 020H, 000H, 020H, 000H ; ?
db      070H, 088H, 0A8H, 0B8H, 0B0H, 080H, 078H, 000H ; @
ASCII_TBL:
db      020H, 050H, 088H, 088H, 0F8H, 088H, 088H, 000H ; A
db      0F0H, 088H, 088H, 0F0H, 088H, 088H, 0F0H, 000H ; B
db      070H, 088H, 080H, 080H, 080H, 088H, 070H, 000H ; C
db      0F0H, 088H, 088H, 088H, 088H, 088H, 0F0H, 000H ; D
db      0F8H, 080H, 080H, 0F0H, 080H, 080H, 0F8H, 000H ; E
db      0F8H, 080H, 080H, 0F0H, 080H, 080H, 080H, 000H ; F
db      078H, 080H, 080H, 080H, 098H, 088H, 078H, 000H ; G
db      088H, 088H, 088H, 0F8H, 088H, 088H, 088H, 000H ; H
db      070H, 020H, 020H, 020H, 020H, 020H, 070H, 000H ; I
db      008H, 008H, 008H, 008H, 008H, 088H, 070H, 000H ; J
db      088H, 090H, 0A0H, 0C0H, 0A0H, 090H, 088H, 000H ; K
db      080H, 080H, 080H, 080H, 080H, 080H, 0F8H, 000H ; L
db      088H, 0D8H, 0A8H, 0A8H, 088H, 088H, 088H, 000H ; M
db      088H, 088H, 0C8H, 0A8H, 098H, 088H, 088H, 000H ; N
db      070H, 088H, 088H, 088H, 088H, 088H, 070H, 000H ; O
db      0F0H, 088H, 088H, 0F0H, 080H, 080H, 080H, 000H ; P
db      070H, 088H, 088H, 088H, 0A8H, 090H, 068H, 000H ; Q

```

```

db      0F0H, 088H, 088H, 0F0H, 0A0H, 090H, 088H, 000H ; R
db      070H, 088H, 080H, 070H, 008H, 088H, 070H, 000H ; S
db      0F8H, 020H, 020H, 020H, 020H, 020H, 020H, 000H ; T
db      088H, 088H, 088H, 088H, 088H, 088H, 070H, 000H ; U
db      088H, 088H, 088H, 088H, 088H, 088H, 050H, 000H ; V
db      088H, 088H, 088H, 0A8H, 0A8H, 0D8H, 088H, 000H ; W
db      088H, 088H, 050H, 020H, 050H, 088H, 088H, 000H ; X
db      088H, 088H, 050H, 020H, 020H, 020H, 020H, 000H ; Y
db      0F8H, 008H, 010H, 020H, 040H, 080H, 0F8H, 000H ; Z
db      0F8H, 0C0H, 0C0H, 0C0H, 0C0H, 0C0H, 0F8H, 000H ; [
db      000H, 080H, 040H, 020H, 010H, 008H, 000H, 000H ; \
db      0F8H, 018H, 018H, 018H, 018H, 018H, 0F8H, 000H ; ]
db      000H, 000H, 020H, 050H, 088H, 000H, 000H, 000H ; ^
db      000H, 000H, 000H, 000H, 000H, 000H, 000H, 0F8H ; _
db      040H, 020H, 010H, 000H, 000H, 000H, 000H, 000H ; `
db      000H, 000H, 070H, 088H, 0F8H, 088H, 088H, 000H ; a
db      000H, 000H, 0F0H, 048H, 070H, 048H, 0F0H, 000H ; b
db      000H, 000H, 078H, 080H, 080H, 080H, 078H, 000H ; c
db      000H, 000H, 0F0H, 048H, 048H, 048H, 0F0H, 000H ; d
db      000H, 000H, 0F0H, 080H, 0E0H, 080H, 0F0H, 000H ; e
db      000H, 000H, 0F0H, 080H, 0E0H, 080H, 080H, 000H ; f
db      000H, 000H, 078H, 080H, 0B8H, 088H, 070H, 000H ; g
db      000H, 000H, 088H, 088H, 0F8H, 088H, 088H, 000H ; h
db      000H, 000H, 0F8H, 020H, 020H, 020H, 0F8H, 000H ; i
db      000H, 000H, 070H, 020H, 020H, 0A0H, 0E0H, 000H ; j
db      000H, 000H, 090H, 0A0H, 0C0H, 0A0H, 090H, 000H ; k
db      000H, 000H, 080H, 080H, 080H, 080H, 0F8H, 000H ; l
db      000H, 000H, 088H, 0D8H, 0A8H, 088H, 088H, 000H ; m
db      000H, 000H, 088H, 0C8H, 0A8H, 098H, 088H, 000H ; n
db      000H, 000H, 0F8H, 088H, 088H, 088H, 0F8H, 000H ; o
db      000H, 000H, 0F0H, 088H, 0F0H, 080H, 080H, 000H ; p
db      000H, 000H, 0F8H, 088H, 0A8H, 090H, 0E0H, 000H ; q
db      000H, 000H, 0F8H, 088H, 0F8H, 0A0H, 090H, 000H ; r
db      000H, 000H, 078H, 080H, 070H, 008H, 0F0H, 000H ; s
db      000H, 000H, 0F8H, 020H, 020H, 020H, 020H, 000H ; t
db      000H, 000H, 088H, 088H, 088H, 088H, 070H, 000H ; u
db      000H, 000H, 088H, 088H, 090H, 0A0H, 040H, 000H ; v
db      000H, 000H, 088H, 088H, 0A8H, 0D8H, 088H, 000H ; w
db      000H, 000H, 088H, 060H, 020H, 060H, 088H, 000H ; x
db      000H, 000H, 088H, 050H, 020H, 020H, 020H, 000H ; y
db      000H, 000H, 0F8H, 010H, 020H, 040H, 0F8H, 000H ; z
db      038H, 040H, 020H, 0C0H, 020H, 040H, 038H, 000H ; {
db      040H, 020H, 010H, 008H, 010H, 020H, 040H, 000H ; |
db      0E0H, 010H, 020H, 018H, 020H, 010H, 0E0H, 000H ; }
db      040H, 0A8H, 010H, 000H, 000H, 000H, 000H, 000H ; ~
db      0A8H, 050H, 0A8H, 050H, 0A8H, 050H, 0A8H, 000H ; (deleted)
OBJ_TABLE:
db      001H, 002H, 00EH, 00FH, 008H, 009H, 012H, 013H
db      003H, 004H, 00EH, 00FH, 005H, 014H, 000H, 000H
db      005H, 000H, 010H, 011H, 00AH, 00BH, 015H, 016H
db      006H, 007H, 010H, 011H, 005H, 014H, 000H, 000H
db      001H, 002H, 00EH, 00FH, 003H, 004H, 00EH, 00FH
db      003H, 004H, 00EH, 00FH, 00CH, 00DH, 017H, 018H
db      0FFH ; END OF TABLE INDICATOR
;
; Desc.: Writes DE number of time a byte value in vram at HL address
; INPUT : HL = INDEX IN VRAM, A = BYTE TO COPY, DE = COUNT
; AFFECT AF, DE (reset to 0) and C (equal the input value A)
;
FILL_VRAM_:
ld      c,a
ld      a,l
out     (CTRL_PORT),a

```

```

        ld    a,h
        or    040H
        out   (CTRL_PORT),a
FILL:   ld    a,c
        out   (DATA_PORT),a
        dec   de
        ld    a,d
        or    e
        jr    nz,FILL
        call  READ_REGISTER
        ret

;
MODE_1_:
        ld    b,000H
        ld    c,000H
        call  WRITE_REGISTER
        ld    b,001H
        ld    c,080H
        call  WRITE_REGISTER
        ld    a,002H
        ld    hl,01800H
        call  INIT_TABLE
        ld    a,004H
        ld    hl,02000H
        call  INIT_TABLE
        ld    a,003H
        ld    hl,00000H
        call  INIT_TABLE
        ld    a,000H
        ld    hl,01B00H
        call  INIT_TABLE
        ld    a,001H
        ld    hl,03800H
        call  INIT_TABLE
        ld    b,007H
        ld    c,000H
        call  WRITE_REGISTER
        ret

;
; Desc.: Writes out ASCII character generators to the pattern
;         generator table. INIT_TABLE must be used to set up
;         the table address.
;
LOAD_ASCII_:
        ld    hl,ASC_TABLE ; Location of generators
        ld    de,0001DH    ; Offset to place ASC_TABLE
        ld    iy,00060H    ; in the correct location
        ld    a,003H
        call  PUT_VRAM
        ld    hl,SPACE
        ld    de,00000H
        ld    iy,00001H
        ld    a,003H
        call  PUT_VRAM
        ret

;
PARSE:
        ld    bc,00000H    ; From HL increment BC until
P_LOOP:
        ld    a,(hl) ; [HL] = "/"
        cp    02FH
        ret    z

```

```

        inc    hl
        inc    bc
        jr     P_LOOP
;
CENTER_PRT:
        push   bc      ; BC = LEN$
        pop    iy      ; IY = #items to be transferred in PUT_VRAM
        ld     a,020H ; DE = Location of start of string
        sbc    a,c      ; A = 32-C
        rra     ; DIV 2
        ld     b,000H
        ld     c,a
        add    hl,bc
        ld     b,h
        ld     c,l
        ld     h,d
        ld     l,e
        ld     d,b
        ld     e,c
        ld     a,002H
        call   PUT_VRAM
        ret
;
DELAY_10:
        ld     hl,01700H
TIMER_1:
        ld     de,000FFH
TIMER_2:
        dec    de
        ld     a,d
        or     e
        jr     nz,TIMER_2
        dec    hl
        ld     a,h
        or     l
        jr     nz,TIMER_1
        ret

```

## GAME OPTION

```
; Displays the game option screen with white letters on a blue background.
; VDP is left in mode 1 with the VRAM memory map as follows.
;
;           VDP MEMORY MAP
;   3800H-3FFFH  SPRITE GENERATOR TABLE
;   2000H-201FH  PATTERN COLOR TABLE
;   1B00H-1B7FH  SPRITE ATTRIBUTE TABLE
;   1800H-1AFFH  PATTERN NAME TABLE
;   0000H-17FFH  PATTERN GENERATOR TABLE
;
; #External
; EXT  PUT_VRAM
; EXT  WRITE_REGISTER
; EXT  COLORTABLE
; EXT  LOAD_ASCII
; EXT  FILL_VRAM
; EXT  MODE_1
;
; #Global
; GLB  GAME_OPT_
;

; ***** Display game option screen *****
GAME_OPT_:
; ***** CLEAR 16K VRAM *****
    ld    hl,00000H
    ld    de,04000H
    ld    a,000H
    call  FILL_VRAM
; ***** Set up VDP with mode 1 *****
    call  MODE_1
; ***** Set up background color *****
; Note: 0 = Black (default background color)
;       F = White (default forecolor not used in mode 1)
    ld    b,00FH
    ld    c,004H
    call  WRITE_REGISTER
; ***** Write out PATTERN_GEN_TABLE *****
    call  LOAD_ASCII
; ***** Write out PATTERN_NAME_TABLE *****
    ld    hl,LINE_1
    ld    de,00025H
    ld    iy,00016H
    ld    a,002H
    call  PUT_VRAM
    ld    hl,LINE_2
    ld    de,00065H
    ld    iy,00017H
    ld    a,002H
    call  PUT_VRAM
    ld    de,000C5H
    call  WRITE_L3
    ld    de,00105H
    call  WRITE_L3
    ld    de,00145H
    call  WRITE_L3
    ld    de,00185H
    call  WRITE_L3
    ld    de,001E5H
```

```

call    WRITE_L3
ld      de,00225H
call    WRITE_L3
ld      de,00265H
call    WRITE_L3
ld      de,002A5H
call    WRITE_L3
ld      de,00105H
call    WRITE_L4
ld      de,00145H
call    WRITE_L5
ld      de,00185H
call    WRITE_L6
ld      hl,LINE_7
ld      de,001E5H
call    WRITE_CHAR
ld      hl,LINE_8
ld      de,00225H
call    WRITE_CHAR
ld      hl,LINE_9
ld      de,00265H
call    WRITE_CHAR
ld      hl,LINE_10
ld      de,002A5H
call    WRITE_CHAR
ld      de,0010FH
call    WRITE_L4
ld      de,0014FH
call    WRITE_L5
ld      de,0018FH
call    WRITE_L6
ld      de,001F1H
call    WRITE_L11
ld      de,00231H
call    WRITE_L11
ld      de,00271H
call    WRITE_L11
ld      de,002B1H
call    WRITE_L11
ld      de,0022FH
call    WRITE_L4
ld      de,0026FH
call    WRITE_L5
ld      de,002AFH
call    WRITE_L6
ld      de,001FBH
call    WRITE_L12
ld      de,0023bH
call    WRITE_L12
ld      de,0027BH
call    WRITE_L12
ld      de,002BBH
call    WRITE_L12
; ***** Write out COLOR_NAME_TABLE *****
; Note: F = White, 4 = Blue
ld      hl,(COLORTABLE)
ld      de,00020H
ld      a,0F4H
call    FILL_VRAM
; ***** Enable display *****
ld      b,001H
ld      c,0C0H
call    WRITE_REGISTER

```

```

        ret
; ***** DATA TABLES *****
LINE_1:
    db      "TO SELECT GAME OPTION,"
LINE_2:
    db      "PRESS BUTTON ON KEYPAD."
LINE_3:
    db      "1 = SKILL 1/ONE PLAYER"
LINE_4:
    db      "2"
LINE_5:
    db      "3"
LINE_6:
    db      "4"
LINE_7:
    db      "5"
LINE_8:
    db      "6"
LINE_9:
    db      "7"
LINE_10:
    db      "8"
LINE_11:
    db      "TWO"
LINE_12:
    db      "S"
; ***** LOCAL SUBROUTINES *****
WRITE_L3:
    ld      hl,LINE_3
    ld      iy,00016H
    ld      a,002H
    call    PUT_VRAM
    ret

;
WRITE_L4:
    ld      hl,LINE_4
    jr      WRITE_CHAR

;
WRITE_L5:
    ld      hl,LINE_5
    jr      WRITE_CHAR

;
WRITE_L6:
    ld      hl,LINE_6
WRITE_CHAR:
    ld      iy,00001H
    ld      a,002H
    call    PUT_VRAM
    ret

;
WRITE_L11:
    ld      hl,LINE_11
    ld      iy,00003H
    ld      a,002H
    call    PUT_VRAM
    ret

;
WRITE_L12:
    ld      hl,LINE_12
    ld      iy,00001H
    ld      a,002H
    call    PUT_VRAM
    ret

```

## TABLE MANAGER

```

; #Define
; TRUE EQU 1
;
; #External
; EXT VRAM_WRITE,REG_WRITE,VRAM_READ
; EXT VDP_MODE_WORD
; EXT MUX_SPRITES
; EXT PARAM_
; EXT LOCAL_SPR_TBL,SPRITE_ORDER
;
; #Global
; GLB INIT_TABLE_,GET_VRAM_,PUT_VRAM_,INIT_SPR_ORDER_,WR_SPR_NM_TBL_
; GLB INIT_TABLEQ,GET_VRAMQ,PUT_VRAMQ,INIT_SPR_ORDERQ,WR_SPR_NM_TBLQ
;
DATA_PORT EQU 0BEH
CTRL_PORT EQU 0BFH

;
; PROCEDURE INIT_TABLEQ (TABLE_CODE:BYTE;TABLE_ADDRESS:INTEGER)
;
INIT_TABLE_P:
    dw    00002H
    dw    00001H
    dw    00002H
;
INIT_TABLEQ:
    ld     bc,INIT_TABLE_P
    ld     de,PARAM_AREA
    call   PARAM_
    ld     a,(PARAM_AREA)
    ld     hl,(PARAM_AREA+1)
;
; INIT_TABLE_
; Desc.: Initializes the table addresses for VRAM tables.
;        Writes the appropriate base address into the
;        respective VDP register.
;
INIT_TABLE_:
    ld     c,a
    ld     b,000H
    ld     ix,VRAM_ADDR_TABLE
    add    ix,bc
    add    ix,bc
    ld     (ix+000H),l
    ld     (ix+001H),h
    ld     a,(VDP_MODE_WORD)
    bit    1,a
    jr     z,INIT_TABLE80
    ld     a,c
    cp     003H
    jr     z,CASE_OF_GEN
    cp     004H
    jr     z,CASE_OF_COLOR
    jr     INIT_TABLE80
;
CASE_OF_GEN:
    ld     b,004H
    ld     a,l
    or     h

```



```

        jr      nz,CASE_OF_GEN10
        ld      c,003H
        jr      INIT_TABLE90
;
CASE_OF_GEN10:
        ld      c,007H
        jr      INIT_TABLE90
;
CASE_OF_COLOR:
        ld      b,003H
        ld      a,l
        or      h
        jr      nz,CASE_OF_CLR10
        ld      c,07FH
        jr      INIT_TABLE90
;
CASE_OF_CLR10:
        ld      c,0FFH
        jr      INIT_TABLE90
;
; ** Compute base address (BASE_ADDRESS=TABLE_ADDRESS/FACTOR)
; ** Get bit shift count
INIT_TABLE80:
        ld      iy,BASE_FACTORS
        add     iy,bc
        add     iy,bc
        ld      a,(iy+000H)
        ld      b,(iy+001H)
DIVIDE:
        srl     h
        rr      l
        dec     a
        jr      nz,DIVIDE
        ld      c,l
INIT_TABLE90:
        call    REG_WRITE
        ret
;
BASE_FACTORS:
        db      007H
        db      005H
        db      00BH
        db      006H
        db      00AH
        db      002H
        db      00BH
        db      004H
        db      006H
        db      003H

;
; PROCEDURE GET_VRAMQ (TABLE_CODE:BYTE;START_INDEX:BYTE;SLICE:BYTE;
;                      VAR_DATA:BUFFER;ITEM_COUNT:INTEGER)
;
GET_VRAM_P:
        dw      00005H
        dw      00001H
        dw      00001H
        dw      00001H
        dw      0FFFEH
        dw      00002H
;
GET_VRAMQ:

```

```

        ld      bc,GET_VRAM_P
        ld      de,PARAM_AREA
        call    PARAM_
        ld      a,(PARAM_AREA)
        ld      de,(PARAM_AREA+1)
        ld      iy,(PARAM_AREA+5)
        ld      hl,(PARAM_AREA+3)
;
; GET_VRAM_
; Desc.: Gets a certain number of bytes from VRAM
;        and puts them in a buffer.
; Input: TABLE_CODE in A
;        0=SPRITE_NAME_TABLE
;        1=SPRITE_GENERATOR_TABLE
;        2=PATTERN_NAME_TABLE
;        3=PATTERN_GENERATOR_TABLE
;        4=COLOR_TABLE
;        START_INDEX in DE
;        DATA_BUFFER in HL
;        COUNT in IY
;
GET_VRAM_:
        call    SET_COUNT
        call    VRAM_READ
        ret
;
; SET_COUNT
; Desc.: Called by PUT_VRAM_ and GET_VRAM_
;        Sets byte count and index for writes
;        and reads to and from VRAM
;
;        TABLE          BYTES/ITEM
;        SPRITE_NAME      4
;        SPRITE_GEN        8
;        PATTERN_NAME     1
;        PATTERN_GEN      8
;        COLOR (MODE 1)   1
;        COLOR (MODE 2)   8
;
SET_COUNT:
        ld      (SAVED_COUNT),iy
        ld      ix,VRAM_ADDR_TABLE
        ld      c,a
        ld      b,000H
        cp      004H
        jr      nz,SET_COUNT10
        ld      a,(VDP_MODE_WORD)
        bit     1,a
        jr      z,SET_COUNT20
SET_COUNT10:
        ld      iy,SHIFT_CT
        add     iy,bc
        ld      a,(iy+000H)
        cp      000H
        jr      z,SET_COUNT20
ADJUST_INDEX:
        sla     e
        rl      d
        dec     a
        jr      nz,ADJUST_INDEX
END_ADJ_INDEX:
        push    bc
        ld      bc,(SAVED_COUNT)

```

```

        ld    a, (iy+000H)
        cp    000H
        jr    z, END_ADJ_COUNT
ADJUST_COUNT:
        sla    c
        rl    b
        dec    a
        jr    nz, ADJUST_COUNT
        ld    (SAVED_COUNT), bc
END_ADJ_COUNT:
        pop    bc
SET_COUNT20:
        push   hl
        add    ix, bc
        add    ix, bc
        ld    l, (ix+000H)
        ld    h, (ix+001H)
        add    hl, de
        ex     de, hl
        pop    hl
        ld    bc, (SAVED_COUNT)
        ret

;
SHIFT_CT:
        db     002H
        db     003H
        db     000H
        db     003H
        db     003H

;
;  PROCEDURE PUT_VRAMQ (TABLE_CODE:BYTE;START_INDEX:BYTE;SLICE:BYTE;
;                      VAR_DATA:BUFFER;ITEM_COUNT:INTEGER)
;
PUT_VRAM_P:
        dw     00005H
        dw     00001H
        dw     00001H
        dw     00001H
        dw     0FFFEH
        dw     00002H

;
PUT_VRAMQ:
        ld     bc, PUT_VRAM_P
        ld     de, PARAM_AREA
        call   PARAM_
        ld     a, (PARAM_AREA)
        ld     de, (PARAM_AREA+1)
        ld     iy, (PARAM_AREA+5)
        ld     hl, (PARAM_AREA+3)

;
;  PUT_VRAM_
;  Desc.: Writes a certain number of bytes to VRAM
;         from a buffer.
;  Input: TABLE_CODE in A
;         0=SPRITE_NAME_TABLE
;         1=SPRITE_GENERATOR_TABLE
;         2=PATTERN_NAME_TABLE
;         3=PATTERN_GENERATOR_TABLE
;         4=COLOR_TABLE
;         START_INDEX in DE
;         DATA_BUFFER in HL
;         COUNT in IY

```

```

;
PUT_VRAM_:
    push    af
    cp      000H
    jr      nz,ELSEZZ
    ld      a,(MUX_SPRITES)
    cp      001H
    jr      nz,ELSEZZ
    pop     af
    push    hl
    ld      hl,(LOCAL_SPR_TABLE)
    ld      a,e
    sla     a
    sla     a
    ld      e,a
    add     hl,de
    ex      de,hl
    push    iy
    pop     bc
    ld      a,c
    sla     a
    sla     a
    ld      c,a
    pop     hl
    ldir
    jr      END_IFZZ
;
ELSEZZ:
    pop     af
    call    SET_COUNT
    call    VRAM_WRITE
END_IFZZ:
    ret
;
; PROCEDURE INIT_SPR_ORDERQ (SPRITE_COUNT:BYTE)
;
INIT_SPR_P:
    dw      00001H
    dw      00001H
;
INIT_SPR_ORDERQ:
    ld      bc,INIT_SPR_P
    ld      de,PARAM_AREA
    call    PARAM_
    ld      a,(PARAM_AREA)
;
; INIT_SPR_ORDER_
; Desc.: Initializes the sprite display order list in RAM
;         to default order (0..31)
; Input: Number of sprites to order in A
;
INIT_SPR_ORDER_:
    ld      b,a
    xor     a
    ld      hl,(SPRITE_ORDER)
INIT_SPR10:
    ld      (hl),a
    inc     hl
    inc     a
    cp      b
    jr      nz,INIT_SPR10
    ret
;

```

```

; PROCEDURE WR_SPR_NM_TBLQ (SPRITE_COUNT:BYTE)
;
WR_SPR_P:
    dw    00001H
    dw    00001H
;
WR_SPR_NM_TBLQ:
    ld     bc,WR_SPR_P
    ld     de,PARAM_AREA
    call   PARAM_
    ld     a,(PARAM_AREA)
;
; WR_SPR_NM_TBL_
; Desc.: Writes SPRITE_NAME_TABLE to VRAM
;        using the sprite order list.
; Input: Number of sprites to write in A
;
WR_SPR_NM_TBL_:
    ld     ix,(SPRITE_ORDER)
    push   af
    ld     iy,VRAM_ADDR_TABLE
    ld     e,(iy+000H)
    ld     d,(iy+001H)
    ld     a,e
    out    (CTRL_PORT),a
    ld     a,d
    or     040H
    out    (CTRL_PORT),a
    pop    af
OUTPUT_LOOP_TABLE_MA:
    ld     hl,(LOCAL_SPR_TABLE)
    ld     c,(ix+000H)
    inc    ix
    ld     b,000H
    add    hl,bc
    add    hl,bc
    add    hl,bc
    add    hl,bc
    ld     b,004H
    ld     c,DATA_PORT
OUTPUT_LOOP10:
    outi
    nop
    nop                ; delay
    jr     nz,OUTPUT_LOOP10
    dec    a
    jr     nz,OUTPUT_LOOP_TABLE_MA
    ret

```

## **DRIVERS FOR 9928 VDG**

```
; The video drivers provide a standard protocol for the low-level communication
; with the 9918/28 VDP. There are four basic driver routines which between
; them allow the programmer to write a value to a VDP register, read the
; VDP status register, write a RAM or ROM buffer to a specified address
; in VRAM, and read a RAM buffer from a specified address in VRAM.
;
; The four routines outlined above are:
;
;   Procedure Reg_Write
;
;   Reg_Write takes a VDP register number (0..7) in the B register
;   and a byte value to be written to it in the C register. It writes
;   the value to the given VDP register and returns.
;
;   If the specified register is one of the VDP mode control registers,
;   ie. 0 or 1, the Reg_Write also writes the given value to the
;   corresponding half of the VDP_More_Word in RAM. All mode dependant
;   decisions made by the operating system are made by referencing the
;   contents of this word. Thus it is important for the cartridge
;   programmer to maintain it should he/she choose not to use
;   Reg_Write in accessing the VDP registers.
;
;   In addition to the BC pair, Reg_Write also makes use of AF.
;
;   Procedure Reg_Read
;
;   Reg_Read reads the VDP status register and returns its contents
;   in the A register.
;
;   It uses no other registers
;
;   NOTE ***** While this routine has no side effects with respect to
;                   the CPU, it should be used with caution since reads
;                   to the status register have the effect of resetting the
;                   VDP interrupt flag and may cause field interrupts to be
;                   missed.
;
;   Procedure Vram_Write
;
;   Vram_Write takes a pointer to the beginning of the data buffer in the
;   HL pair, the VRAM destination address in the DE pair, and a byte
;   count in the BC pair.
;
;   It writes the specified number of bytes from the buffer to VRAM
;   starting at the destination address.
;
;   The AF,BC,DE, and HL register pairs are all affected.
;
;   NOTE ***** This procedure is not re-entrant.
;
;   Procedure Vram_Read
;
;   Vram_Read takes a pointer to the beginning of the data buffer in the
;   HL pair, the VRAM source address in the DE pair, and a byte count
;   in the BC pair.
;
;   It reads the specified number of bytes into the buffer from VRAM
;   starting at the destination address.
;
```

```

; The AF,BC,DE, and HL register pairs are all affected.
;
; NOTE ***** This procedure is not re-entrant.
;
; For each of the routines listed above, there is an additional entry
; point which allows the routine to be called using the standard pascal
; 64000 parameter passing protocol and passing the parameters through
; a common data area into the registers. It should not be noted that use of
; these routines in this fashion any cause problems in an interrupt
; driven environment. They should therefor be used with care. If the
; name of a given routine is Name, the name of the additional entry point
; is NameQ for the actual routine named NameP when called through the
; jump table in OS ROM. "Q" entry points destroy all registers.
; *****

; ***** DICTIONARY *****
; #Define
DATA_PORT EQU 0BEH
CTRL_PORT EQU 0BFH
;
; #External
; EXT PARAM_
;
; #Common
; PARAM_AREA DEFS 6
;
; #Global
; GLB DATA_PORT,CTRL_PORT
; GLB REG_WRITE_P ; ??
; GLB REG_WRITE,VRAM_WRITE,VRAM_READ
; GLB REG_WRITEQ,VRAM_WRITEQ,VRAM_READQ
; *****

; ***** PROCEDURES AND FUNCTIONS *****
;
; PROCEDURE REG_WRITEQ (REGISTER:BYTE;VALUE:BYTE)
; - REGISTER is passed to B register.
; - VALUE is passed to C register.
; - DESTROYS: A

REG_WRITE_P:
    dw 00002H
    dw 00001H
    dw 00001H
;
REG_WRITEQ:
    ld bc,REG_WRITE_P
    ld de,PARAM_AREA
    call PARAM_
    ld hl,(PARAM_AREA)
    ld c,h
    ld b,l
REG_WRITE:
    ld a,c
    out (CTRL_PORT),a
    ld a,b
    add a,080H
    out (CTRL_PORT),a
    ld a,b
    cp 000H
    jr nz,NOT_REG_0
    ld a,c
    ld (VDP_MODE_WORD),a

```

```

NOT_REG_0:
    ld    a,b
    cp    001H
    jr    nz,NOT_REG_1
    ld    a,c
    ld    (VDP_MODE_WORD+1),a
NOT_REG_1:
    ret

; PROCEDURE VRAM_WRITEQ (VAR_DATA:BUFFER;DEST:INTEGER;COUNT:INTEGER)
; - VAR_DATA (pointer to data buffer) is passed in HL
; - DEST is passed in DE
; - COUNT is passed in BC
; - DESTROYS: ALL

VRAM_WRITE_P:
    dw    00003H
    dw    0FFFEH
    dw    00002H
    dw    00002H
;
WRITE_VRAMQ:
    ld    bc,VRAM_WRITE_P
    ld    de,PARAM_AREA
    call  PARAM_
    ld    hl,(PARAM_AREA)
    ld    de,(PARAM_AREA+2)
    ld    bc,(PARAM_AREA+4)
VRAM_WRITE:
    push  hl
    push  de
    pop   hl
    ld    de,04000H
    add   hl,de
    ld    a,l
    out   (CTRL_PORT),a
    ld    a,h
    out   (CTRL_PORT),a
    push  bc
    pop   de
    pop   hl
    ld    c, DATA_PORT
    ld    b,e
OUTPUT_LOOP:
    outi
    nop
    nop
    jp    nz,OUTPUT_LOOP
    dec  d
    jp    m,END_OUTPUT
    jr    nz,OUTPUT_LOOP
END_OUTPUT:
    ret

; PROCEDURE VRAM_READQ (VAR_DATA:BUFFER;SRCE:INTEGER;COUNT:INTEGER)
; - VAR_DATA (pointer to data buffer) is passed in HL
; - SRCE is passed in DE
; - COUNT is passed in BC
; - DESTROYS: ALL

VRAM_READ_P:
    dw    00003H
    dw    0FFFEH

```



```

        dw      00002H
        dw      00002H
;
READ_VRAMQ:
        ld      bc,VRAM_READ_P
        ld      de,PARAM_AREA
        call    PARAM_
        ld      hl,(PARAM_AREA)
        ld      de,(PARAM_AREA+2)
        ld      bc,(PARAM_AREA+4)
VRAM_READ:
        ld      a,e
        out     (CTRL_PORT),a
        ld      a,d
        out     (CTRL_PORT),a
        push    bc
        pop     de
        ld      c, DATA_PORT
        ld      b,e
INPUT_LOOP:
        ini
        nop
        nop
        jp      nz,INPUT_LOOP
        dec     d
        jp      m,END_INPUT
        jr      nz,INPUT_LOOP
END_INPUT:
        ret
;
REG_READ:
        in      a,(0BFH)
        ret

```

## GRAPHICS PRIM PKG

```
; This is a package of routines that allow applications programmers to
; operate on shape generators. Each of them takes, as inputs, an area
; in one of the generator tables in which the generators to be operated
; upon reside, a count of the generators to be used, and an area of the
; same table into which the results are to be put. The only RAM area they
; is in the WORK_BUFFER a pointer to which is declared as an external
; and defined in the cartridge.

; ***** NOTE: *****
; ***** THESE ROUTINES WRITE TO AND READ *****
; ***** WITHOUT POSSIBILITY OF DEFERAL *****
; ***** AND SHOULD NOT BE USED IN ANY *****
; ***** SITUATION WHERE THEY MAY BE *****
; ***** INTERRUPTED. *****
; ***** *****

; #Define
; TRUE EQU 1
; FALSE EQU 0
; PATTERN_GEN EQU 3
; COLOR_TABLE EQU 4
;
; #External
; EXT WORK_BUFFER
;
; #Global
; GLB RFLCT_VERT,RFLCT_HOR,ROT_90,ENLRG

;
; PROCEDURE:
; REFLECT_VERTICAL (TABLE_CODE(A),SOURCE(DE),DESTINATION(HL),COUNT(BC))
;
; It reflects each of a block of generators from VRAM around the vertical axis.
; If the generators are from the pattern plane and the graphics mode is 2, then
; the routine also copies the corresponding color generators., otherwise is
; assumes that the color data has already been set up.
;
; BEGIN REFLECT_VERTICAL
;
RFLCT_VERT:
    ld ix,RFLCT_VERT_
    jr CONTINUE_GRAPHICS
;
; PROCEDURE:
; REFLECT_HORIZONTAL (TABLE_CODE(A),SOURCE(DE),DESTINATION(HL),COUNT(BC))
;
; It reflects each of a block of generators from VRAM around the horizontal
; axis. If the generators are from the pattern plane and the graphics mode is
; 2, then it reflects the corresponding color generators as well.
;
; BEGIN REFLECT_HORIZONTAL
;
RFLCT_HOR:
    ld ix,RFLCT_HOR_
    jr CONTINUE_GRAPHICS
;
; PROCEDURE:
; ROTATE_90 (TABLE_CODE(A),SOURCE(DE),DESTINATION(HL),COUNT(BC))
;
```

```

; It rotates each of a block of generators from VRAM 90 degrees clockwise.
; If the generators are from the pattern plane and the graphics mode is 2, then
; it copies the corresponding color entries as well.
;
; BEGIN ROTATE_90
;
ROT_90:
    ld    ix,ROT_90_
    jr    CONTINUE_GRAPHICS
;
; PROCEDURE:
; ENLARGE (TABLE_CODE(A),SOURCE(DE),DESTINATION(HL),COUNT(BC))
;
; It takes each of a block of generators and enlarges it into a block of four
; generators where each pixel of the original generator is expanded to four
; pixels in the new ones. If the generators are from the pattern plane and the
; graphics mode is 2 then it also quadruples each of the corresponding color
; generators as well.
;
; BEGIN ENLARGE
;
ENLRG:
    ld    ix,ENLRG_
CONTINUE_GRAPHICS:
    exx
    ex    af,af'
    push  ix
MAIN_LOOP:
    ex    af,af'
    push  af
    ex    af,af'
    pop   af
    exx
    push  de
    exx
    pop   de
    ld    iy,00001H
    ld    hl,(WORK_BUFFER)
    call  GET_VRAM_
    pop   ix
    push  ix
    jp    (ix)          ;INFO: index jump
;
RETURN_HERE:
    inc   de
    dec   bc
    ld    a,b
    or    c
    exx
    jr    nz,MAIN_LOOP
    pop   ix
    ret
;
; RLFCT_VERT_
; Desc.: Operations specific to the REFLECT_VERTICAL routine
;
RLFCT_VERT_:
    ld    hl,(WORK_BUFFER)
    ld    bc,00008H
    push  hl
    pop   de
    add   hl,bc
    ex    de,hl

```

```

        call    MIRROR_L_R
        call    PUT_TABLE
        call    COLOR_TEST
        cp      001H
        jr      nz,END_IF_1_GRAPHICS
        call    GET_COLOR
        call    PUT_COLOR
END_IF_1_GRAPHICS:
        exx
        inc     hl
        jr      RETURN_HERE
;
; RLFCT_HOR_
; Desc.: Operations specific to the REFLECT_HORIZONTAL routine
;
RLFCT_HOR_:
        ld      hl,(WORK_BUFFER)
        ld      bc,00008H
        push    hl
        pop     de
        add     hl,bc
        ex      de,hl
        call    MIRROR_U_D
        call    PUT_TABLE
        call    COLOR_TEST
        cp      001H
        jr      nz,END_IF_2_GRAPHICS
        call    GET_COLOR
        ld      hl,(WORK_BUFFER)
        ld      bc,00008H
        push    hl
        pop     de
        add     hl,bc
        ex      de,hl
        call    MIRROR_U_D
        call    PUT_COLOR
END_IF_2_GRAPHICS:
        exx
        inc     hl
        jr      RETURN_HERE
;
; ROT_90_
; Desc.: Operations specific to the ROTATE_90 routine
;
ROT_90_:
        ld      hl,(WORK_BUFFER)
        ld      bc,00008H
        push    hl
        pop     de
        add     hl,bc
        ex      de,hl
        call    ROTATE
        call    PUT_TABLE
        call    COLOR_TEST
        cp      001H
        jr      nz,END_IF_3_GRAPHICS
        call    GET_COLOR
        call    PUT_COLOR
END_IF_3_GRAPHICS:
        exx
        inc     hl
        jp      RETURN_HERE
;

```

```

; ENLRG_
; Desc.: Operations specific to the ENLARGE routine
;
ENLRG_:
    ld    hl,(WORK_BUFFER)
    ld    bc,00008H
    push  hl
    pop   de
    add   hl,bc
    ex    de,hl
    call  MAGNIFY
    ex    af,af'
    push  af
    ex    af,af'
    pop   af
    exx
    push  hl
    exx
    pop   de
    ld    hl,(WORK_BUFFER)
    ld    bc,00008H
    add   hl,bc
    ld    iy,00004H
    call  PUT_VRAM_
    call  COLOR_TEST
    cp    001H
    jr    nz,END_IF_4_GRAPHICS
    call  GET_COLOR
    ld    hl,(WORK_BUFFER)
    ld    bc,00008H
    push  hl
    pop   de
    add   hl,bc
    ex    de,hl
    call  QUADRUPL
    ld    a,004H
    exx
    push  hl
    exx
    pop   de
    ld    hl,(WORK_BUFFER)
    ld    bc,00008H
    add   hl,bc
    ld    iy,00004H
    call  PUT_VRAM_
END_IF_4_GRAPHICS:
    exx
    inc   hl
    inc   hl
    inc   hl
    inc   hl
    jp    RETURN_HERE
;
; COLOR_TEST
; Desc.: Tests whether pattern generators are being manipulated and wheter the
;         graphics mode is 2. If so the above routines need to deal with the
;         color generators that correspond to the pattern generators they are
;         operating on.
; Input: no
; Output: A = 1 if true, 0 if not
;
COLOR_TEST:
    ex    af,af'

```

```

        push    af
        ex      af,af'
        pop     af
        cp      003H
        jr      nz,EXIT_FALSE
        ld      hl,VDP_MODE_WORD
        bit     1,(hl)
        jr      z,EXIT_FALSE
        ld      a,001H
        ret

;
EXIT_FALSE:
        ld      a,000H
        ret

;
; PUT_TABLE
; Desc.: Puts the contents of WORK_BUFFER[8..15]
;        in vram at the given destination.
;
PUT_TABLE:
        ex      af,af'
        push    af
        ex      af,af'
        pop     af
        exx
        push    hl
        exx
        pop     de
        ld      hl,(WORK_BUFFER)
        ld      bc,00008H
        add     hl,bc
        ld      iy,00001H
        call    PUT_VRAM_
        ret

;
; GET_COLOR
; Desc.: Gets the color information from the appropriate place in vram.
;
GET_COLOR:
        ld      a,004H
        exx
        push    de
        exx
        pop     de
        ld      hl,(WORK_BUFFER)
        ld      iy,00001H
        call    GET_VRAM_
        ret

;
; PUT_COLOR
; Desc.: Puts the color information in the appropriate place in vram.
;
PUT_COLOR:
        ld      a,004H
        exx
        push    hl
        exx
        pop     de
        ld      hl,(WORK_BUFFER)
        ld      iy,00001H
        call    PUT_VRAM_
        ret

```

## EXPANSION ROUTINES

; The routines in this module take a single 8-byte block as input and  
; produce 4 8-byte blocks as output. They perform a 2-to-1 expansion  
; and a simple quadrupling operation respectively

```
; #Define
; BYTE_COUNT      EQU BC register
; SOURCE           EQU IX register
; DESTINATION      EQU IY register
;
; #Global
; GLB  MAGNIFY,QUADRULE
```

```
;
; MAGNIFY
; Desc.: Perform a 2-to-1 expansion on an 8-byte block of data.
; Input: HL = Source pointer, DE = Destination pointer
; Destroy: IX, IY, AF, BC, DE, HL
;
```

**MAGNIFY:**

```
    push    hl
    pop     ix
    push    de
    pop     iy
    ld      bc,00008H
MAG_LOOP:
    ld      a,(ix+000H)
    inc     ix
    ld      d,a
    ld      e,004H
EXP_1:
    rl      a
    rl      h
    rl      d
    rl      h
    dec     e
    jr      nz,EXP_1
    ld      e,004H
EXP_2:
    rl      a
    rl      l
    rl      d
    rl      l
    dec     e
    jr      nz,EXP_2
    ld      (iy+000H),h
    ld      (iy+010H),l
    inc     iy
    ld      (iy+000H),h
    ld      (iy+010H),l
    inc     iy
    dec     bc
    ld      a,c
    or      b
    jr      nz,MAG_LOOP
    ret
```

```
;
; QUADRULE
; Desc.: Perform a quadrupling on an 8-byte block of data.
; Input: HL = Source pointer, DE = Destination pointer
```

```

; Destroy: AF, BC, DE
;
QUADRUPLE:
    ld    bc,00010H
    push  hl
QUAD_LOOP:
    ld    a,(hl)
    inc   hl
    ld    (de),a
    inc   de
    ld    (de),a
    inc   de
    dec   bc
    ld    a,c
    cp    008H
    jr    nz,SKIPZZ
    pop   hl
SKIPZZ:
    ld    a,c
    or    b
    jr    nz,QUAD_LOOP
    ret

```



## MIRROR/ROTATE RTN

```
; The routines in this file take a single 8-byte block as input
; and operate on it producing a single 8-byte block as output
; They perform mirroring arround the vertical axis, mirroring
; arround the horizontal axis, and 90 degree rotation

; #Global
; GLB  MIRROR_L_R,MIRROR_U_D,ROTATE

;
; MIRROR_L_R
; Desc.: Reflets an 8x8 pixel data block arround the vertical axis.
; Input: HL = Source pointer, DE = Destination pointer
; Destroy: AF, BC, DE, HL
;
MIRROR_L_R:
    ld    bc,00008H
MIR_L_R10:
    ld    b,(hl)
    ld    a,080H
MIR_L_R20:
    rl    b
    rra
    jr    nc,MIR_L_R20
    ld    (de),a
    inc   hl
    inc   de
    dec   c
    jr    nz,MIR_L_R10
    ret

;
; ROTATE
; Desc.: Rotate object 90 degrees (clockwise).
; Input: HL = Source pointer, DE = Destination pointer
; Destroy: IX, AF, BC, DE, HL
;
ROTATE:
    push  hl
    pop   ix
    ex    de,hl
    ld    bc,00008H
TRANSP_10:
    rl    (ix+000H)
    rr    (hl)
    rl    (ix+001H)
    rr    (hl)
    rl    (ix+002H)
    rr    (hl)
    rl    (ix+003H)
    rr    (hl)
    rl    (ix+004H)
    rr    (hl)
    rl    (ix+005H)
    rr    (hl)
    rl    (ix+006H)
    rr    (hl)
    rl    (ix+007H)
    rr    (hl)
    inc   hl
    dec   c
```

```

        jr      nz,TRANSP_10
        ret
;
; MIRROR_U_D
; Desc.: Reflets 8x8 pixel block arround the horizontal axis.
; Input: HL = Source pointer, DE = Destination pointer
; Destroy: AF, BC, DE, HL
;
MIRROR_U_D:
        ld      bc,00007H
        add     hl,bc
        inc     bc
REFLECT_LOOP:
        ld      a,(hl)
        ld      (de),a
        inc     de
        dec     hl
        dec     bc
        ld      a,b
        or      c
        jr      nz,REFLECT_LOOP
        ret
;
; Modified february 14, 1983.
; Filler locations were changed to 0FFH to reflect OS_7PRIME
;
filler_1f5d:
        db      0FFH
        db      0FFH
        db      0FFH
        db      0FFH

```

## JUMP TABLE

```
; This is the jump table to be used in accessing code residing in the OS ROM.
; This table must have its origin redefined to account for growth. Pile new
; routines at the beginning of the table making sure to increment the
; NO_OF_ROUTINES value.
;
; NOTE ****
;          **** NO DELETIONS SHOULD BE MADE FROM ****
;          **** THIS TABLE ****
; #Define
ROM_END      EQU 2000H    ; This is the end of OS ROM
NO_OF_ROUTINES EQU 53     ; This number keeps count of the number of routines
                        ; accessed through the jump table.

; #Origin
JUMP_TABLE   ORG      ROM_END-(NO_OF_ROUTINES*3)

PLAY_SONGS:
    jp      PLAY_SONGS_      ; ($1F61) See page 86
ACTIVATEP:
    jp      ACTIVATEQ        ; ($1F64) See page 93
PUTOBJP:
    jp      PUTOBJQ          ; ($1F67) See page 102
REFLECT_VERTICAL:
    jp      RFLCT_VERT       ; ($1F6A) See page 168
REFLECT_HORIZONTAL:
    jp      RFLCT_HOR        ; ($1F6D) See page 168
ROTATE_90:
    jp      ROT_90           ; ($1F70) See page 169
ENLARGE:
    jp      ENLRG            ; ($1F73) See page 169
CONTROLLER_SCAN:
    jp      CONT_SCAN        ; ($1F76) See page 140
DECODER:
    jp      DECODER_         ; ($1F79) See page 141
GAME_OPT:
    jp      GAME_OPT_        ; ($1F7C) See page 155
LOAD_ASCII:
    jp      LOAD_ASCII_      ; ($1F7F) See page 153
FILL_VRAM:
    jp      FILL_VRAM_       ; ($1F82) See page 152
MODE_1:
    jp      MODE_1_          ; ($1F85) See page 153
UPDATE_SPINNER:
    jp      UPDATE_SPINNER_  ; ($1F88) See page 141
INIT_TABLEP:
    jp      INIT_TABLEQ      ; ($1F8B) See page 158
GET_VRAM_P:
    jp      GET_VRAMQ        ; ($1F8E) See page 159
PUT_VRAM_P:
    jp      PUT_VRAMQ        ; ($1F91) See page 161
INIT_SPR_ORDERP:
    jp      INIT_SPR_ORDERQ  ; ($1F94) See page 162
WR_SPR_NM_TBLP:
    jp      WR_SPR_NM_TBLQ   ; ($1F97) See page 163
INIT_TIMERP:
    jp      INIT_TIMERQ      ; ($1F9A) See page 133
FREE_SIGNALP:
    jp      FREE_SIGNALQ     ; ($1F9D) See page 133
REQUEST_SIGNALP:
    jp      REQUEST_SIGNALQ  ; ($1FA0) See page 135
```

|                         |                 |                         |
|-------------------------|-----------------|-------------------------|
| <b>TEST_SIGNALP:</b>    |                 |                         |
| jp                      | TEST_SIGNALQ    | ; (\$1FA3) See page 137 |
| <b>WRITE_REGISTERP:</b> |                 |                         |
| jp                      | REG_WRITEQ      | ; (\$1FA6) See page 165 |
| <b>WRITE_VRAMP:</b>     |                 |                         |
| jp                      | WRITE_VRAMQ     | ; (\$1FA9) See page 166 |
| <b>READ_VRAMP:</b>      |                 |                         |
| jp                      | READ_VRAMQ      | ; (\$1FAC) See page 167 |
| <b>INIT_WRITERP:</b>    |                 |                         |
| jp                      | INIT_QUEUEQ     | ; (\$1FAF) See page 100 |
| <b>SOUND_INITP:</b>     |                 |                         |
| jp                      | INIT_SOUNDQ     | ; (\$1FB2) See page 80  |
| <b>PLAY_ITP:</b>        |                 |                         |
| jp                      | JUKE_BOXQ       | ; (\$1FB5) See page 82  |
| <b>INIT_TABLE:</b>      |                 |                         |
| jp                      | INIT_TABLE_     | ; (\$1FB8) See page 158 |
| <b>GET_VRAM:</b>        |                 |                         |
| jp                      | GET_VRAM_       | ; (\$1FBB) See page 160 |
| <b>PUT_VRAM:</b>        |                 |                         |
| jp                      | PUT_VRAM_       | ; (\$1FBE) See page 162 |
| <b>INIT_SPR_ORDER:</b>  |                 |                         |
| jp                      | INIT_SPR_ORDER_ | ; (\$1FC1) See page 162 |
| <b>WR_SPR_NM_TBL:</b>   |                 |                         |
| jp                      | WR_SPR_NM_TBL_  | ; (\$1FC4) See page 163 |
| <b>INIT_TIMER:</b>      |                 |                         |
| jp                      | INIT_TIMER_     | ; (\$1FC7) See page 133 |
| <b>FREE_SIGNAL:</b>     |                 |                         |
| jp                      | FREE_SIGNAL_    | ; (\$1FCA) See page 133 |
| <b>REQUEST_SIGNAL:</b>  |                 |                         |
| jp                      | REQUEST_SIGNAL_ | ; (\$1FCD) See page 135 |
| <b>TEST_SIGNAL:</b>     |                 |                         |
| jp                      | TEST_SIGNAL_    | ; (\$1FD0) See page 137 |
| <b>TIME_MGR:</b>        |                 |                         |
| jp                      | TIME_MGR_       | ; (\$1FD3) See page 131 |
| <b>TURN_OFF_SOUND:</b>  |                 |                         |
| jp                      | ALL_OFF         | ; (\$1FD6) See page 81  |
| <b>WRITE_REGISTER:</b>  |                 |                         |
| jp                      | REG_WRITE       | ; (\$1FD9) See page 165 |
| <b>READ_REGISTER:</b>   |                 |                         |
| jp                      | REG_READ        | ; (\$1FDC) See page 167 |
| <b>WRITE_VRAM:</b>      |                 |                         |
| jp                      | VRAM_WRITE      | ; (\$1FDF) See page 166 |
| <b>READ_VRAM:</b>       |                 |                         |
| jp                      | VRAM_READ       | ; (\$1FE2) See page 167 |
| <b>INIT_WRITER:</b>     |                 |                         |
| jp                      | INIT_QUEUE      | ; (\$1FE5) See page 100 |
| <b>WRITER:</b>          |                 |                         |
| jp                      | WRITER_         | ; (\$1FE8) See page 100 |
| <b>POLLER:</b>          |                 |                         |
| jp                      | POLLER_         | ; (\$1FEB) See page 142 |
| <b>SOUND_INIT:</b>      |                 |                         |
| jp                      | INIT_SOUND      | ; (\$1FEE) See page 80  |
| <b>PLAY_IT:</b>         |                 |                         |
| jp                      | JUKE_BOX        | ; (\$1FF1) See page 82  |
| <b>SOUND_MAN:</b>       |                 |                         |
| jp                      | SND_MANAGER     | ; (\$1FF4) See page 83  |
| <b>ACTIVATE:</b>        |                 |                         |
| jp                      | ACTIVATE_       | ; (\$1FF7) See page 93  |
| <b>PUTOBJ:</b>          |                 |                         |
| jp                      | PUTOBJ_         | ; (\$1FFA) See page 102 |
| <b>RAND_GEN:</b>        |                 |                         |
| jp                      | RAND_GEN_       | ; (\$1FFD) See page 68  |

## APPENDIX

## OS 7' JUMP TABLE

These symbols are entry points to OS 7' routines. They can be directly called by programmers.

Legend:

**P** (at the end): special entry points for Pascal programs.

|                                  |                              |
|----------------------------------|------------------------------|
| 1F61 > 0300 : PLAY_SONGS         | 1FB2 > 0203 : SOUND_INITP    |
| 1F64 > 0488 : ACTIVATEP          | 1FB5 > 0251 : PLAY_ITP       |
| 1F67 > 06C7 : PUTOBJP            | 1FB8 > 1B08 : INIT_TABLE     |
| 1F6A > 1D5A : REFLECT_VERTICAL   | 1FBB > 1BA3 : GET_VRAM       |
| 1F6D > 1D60 : REFLECT_HORIZONTAL | 1FBE > 1C27 : PUT_VRAM       |
| 1F70 > 1D66 : ROTATE_90          | 1FC1 > 1C66 : INIT_SPR_ORDER |
| 1F73 > 1D6C : ENLARGE            | 1FC4 > 1C82 : WR_SPR_NM_TBL  |
| 1F76 > 114A : CONTROLLER_SCAN    | 1FC7 > 0FAA : INIT_TIMER     |
| 1F79 > 118B : DECODER            | 1FCA > 0FC4 : FREE_SIGNAL    |
| 1F7C > 1979 : GAME_OPT           | 1FCD > 1053 : REQUEST_SIGNAL |
| 1F7F > 1927 : LOAD_ASCII         | 1FD0 > 10CB : TEST_SIGNAL    |
| 1F82 > 18D4 : FILL_VRAM          | 1FD3 > 0F37 : TIME_MGR       |
| 1F85 > 18E9 : MODE_1             | 1FD6 > 023B : TURN_OFF_SOUND |
| 1F88 > 116A : UPDATE_SPINNER     | 1FD9 > 1CCA : WRITE_REGISTER |
| 1F8B > 1B0E : INIT_TABLEP        | 1FDC > 1D57 : READ_REGISTER  |
| 1F8E > 1B8C : GET_VRAMP          | 1FDF > 1D01 : WRITE_VRAM     |
| 1F91 > 1C10 : PUT_VRAMP          | 1FE2 > 1D3E : READ_VRAM      |
| 1F94 > 1C5A : INIT_SPR_ORDERP    | 1FE5 > 0664 : INIT_WRITER    |
| 1F97 > 1C76 : WR_SPR_NM_TBLP     | 1FE8 > 0679 : WRITER         |
| 1F9A > 0F9A : INIT_TIMERP        | 1FEB > 11C1 : POLLER         |
| 1F9D > 0FB8 : FREE_SIGNALP       | 1FEE > 0213 : SOUND_INIT     |
| 1FA0 > 1044 : REQUEST_SIGNALP    | 1FF1 > 025E : PLAY_IT        |
| 1FA3 > 10BF : TEST_SIGNALP       | 1FF4 > 027F : SOUND_MAN      |
| 1FA6 > 1CBC : WRITE_REGISTERP    | 1FF7 > 04A3 : ACTIVATE       |
| 1FA9 > 1CED : WRITE_VRAMP        | 1FFA > 06D8 : PUTOBJ         |
| 1FAC > 1D2A : READ_VRAMP         | 1FFD > 003B : RAND_GEN       |
| 1FAF > 0655 : INIT_WRITERP       |                              |

## GLOBAL OS 7' SYMBOLS

### SYMBOLS IN ALPHABETIC ORDER

| ADDRESS | NAME            | DESCRIPTION                                         |
|---------|-----------------|-----------------------------------------------------|
| 01B1    | ADD816          | Add signed 8bit value A to 16bit [HL]               |
| 0069    | AMERICA         | 60 = NTSC, 50 = PAL                                 |
| 006A    | ASCII_TABLE     | Pointer to uppercase ASCII pattern                  |
| 012F    | ATN_SWEEP       | Attenuation sweep                                   |
| 08C0    | CALC_OFFSET     | Returns DE := offset for the coordinates (E,D)      |
| 8000    | CARTRIDGE       | Cartridge starting address                          |
| 8008    | CONTROLLER_MAP  | Pointer to controller memory map                    |
| 1D43    | CTRL_PORT_PTR   | (in READ_VRAM, equal I/O port# BF)                  |
| 1D47    | DATA_PORT_PTR   | (in READ_VRAM, equal I/O port# BE)                  |
| 0190    | DECLSN          | Decrement low nibble (in UTILITY)                   |
| 019B    | DECMSN          | Decrement high nibble (in UTILITY)                  |
| 73C6    | DEFER_WRITES    | Boolean flag to defer writes to VRAM                |
| 02EE    | EFXOVER         | (in PROCESS_DATA_AREA to get next note)             |
| 1D6C    | ENLRG           | It's the <u>local</u> name of the ENLARGE routine   |
| 00FC    | FREQ_SWEEP      | Frequency sweep                                     |
| 8024    | GAME_NAME       | String of ASCII characters                          |
| 0898    | GET_BKGRND      | Copy a block of names from VRAM to RAM              |
| 801E    | IRQ_INT_VECT    | Software interrupt vector (RST 38H)                 |
| 01D5    | LEAVE_EFFECT    | Called by a special sound effect function when done |
| 8002    | LOCAL_SPR_TABLE | Pointer to sprite name table                        |
| 01A6    | MSNTOLSN        | Copy high nibble to low nibble (in UTILITY)         |
| 73C7    | MUS_SPRITES     | Boolean flag to sprite multiplexing                 |
| 8021    | NMI_INT_VECT    | NMI soft vector                                     |
| 006C    | NUMBER_TABLE    | Pointer to numbers 0-9 pattern                      |
| 080B    | PUT_FRAME       | Copy a block of names to VRAM                       |
| 07E8    | PX_TO_PTRN_POS  | Pixel to pattern plane position                     |
| 73C9    | RAND_NUM        | Pointer to pseudo random number value               |
| 800F    | RST_10H_RAM     | Reset 10 soft vector                                |
| 8012    | RST_18H_RAM     | Reset 18 soft vector                                |
| 8015    | RST_20H_RAM     | Reset 20 soft vector                                |
| 8018    | RST_28H_RAM     | Reset 28 soft vector                                |
| 801B    | RST_30H_RAM     | Reset 30 soft vector                                |
| 800C    | RST_8H_RAM      | Reset 8 soft vector                                 |
| 8004    | SPRITE_ORDER    | Pointer to sprite order table                       |
| 73B9    | STACK           | Stack pointer address                               |
| 800A    | START_GAME      | Pointer to game start code                          |
| 73C3    | VDP_MODE_WORD   | Copy of the first two VDP registers                 |
| 73C5    | VDP_STATUS_BYTE | Contents of default NMI handler                     |
| 8006    | WORK_BUFFER     | Pointer to temporary storage in RAM                 |

## SYMBOLS ORDERED BY ADDRESSES

| ADDRESS | NAME            | DESCRIPTION                                         |
|---------|-----------------|-----------------------------------------------------|
| 0069    | AMERICA         | 60 = NTSC, 50 = PAL                                 |
| 006A    | ASCII_TABLE     | Pointer to uppercase ASCII pattern                  |
| 006C    | NUMBER_TABLE    | Pointer to numbers 0-9 pattern                      |
| 00FC    | FREQ_SWEEP      | Frequency sweep                                     |
| 012F    | ATN_SWEEP       | Attenuation sweep                                   |
| 0190    | DECLSN          | Decrement low nibble (in UTILITY)                   |
| 019B    | DECMSN          | Decrement high nibble (in UTILITY)                  |
| 01A6    | MSNTOLSN        | Copy high nibble to low nibble (in UTILITY)         |
| 01B1    | ADD816          | Add signed 8bit value A to 16bit [HL]               |
| 01D5    | LEAVE_EFFECT    | Called by a special sound effect function when done |
| 02EE    | EFXOVER         | (in PROCESS_DATA_AREA to get next note)             |
| 07E8    | PX_TO_PTRN_POS  | Pixel to pattern plane position                     |
| 080B    | PUT_FRAME       | Copy a block of names to VRAM                       |
| 0898    | GET_BKGRND      | Copy a block of names from VRAM to RAM              |
| 08C0    | CALC_OFFSET     | Returns DE := offset for the coordinates (E,D)      |
| 1D43    | CTRL_PORT_PTR   | (in READ_VRAM, equal I/O port# BF)                  |
| 1D47    | DATA_PORT_PTR   | (in READ_VRAM, equal I/O port# BE)                  |
| 1D6C    | ENLARG          | It's the <u>local</u> name of the ENLARGE routine   |
| 73B9    | STACK           | Stack pointer address                               |
| 73C3    | VDP_MODE_WORD   | Copy of the first two VDP registers                 |
| 73C5    | VDP_STATUS_BYTE | Contents of default NMI handler                     |
| 73C6    | DEFER_WRITES    | Boolean flag to defer writes to VRAM                |
| 73C7    | MUS_SPRITES     | Boolean flag to sprite multiplexing                 |
| 73C9    | RAND_NUM        | Pointer to pseudo random number value               |
| 8000    | CARTRIDGE       | Cartridge starting address                          |
| 8002    | LOCAL_SPR_TABLE | Pointer to sprite name table                        |
| 8004    | SPRITE_ORDER    | Pointer to sprite order table                       |
| 8006    | WORK_BUFFER     | Pointer to temporary storage in RAM                 |
| 8008    | CONTROLLER_MAP  | Pointer to controller memory map                    |
| 800A    | START_GAME      | Pointer to game start code                          |
| 800C    | RST_8H_RAM      | Reset 8 soft vector                                 |
| 800F    | RST_10H_RAM     | Reset 10 soft vector                                |
| 8012    | RST_18H_RAM     | Reset 18 soft vector                                |
| 8015    | RST_20H_RAM     | Reset 20 soft vector                                |
| 8018    | RST_28H_RAM     | Reset 28 soft vector                                |
| 801B    | RST_30H_RAM     | Reset 30 soft vector                                |
| 801E    | IRQ_INT_VECT    | Software interrupt vector (RST 38H)                 |
| 8021    | NMI_INT_VECT    | NMI soft vector                                     |
| 8024    | GAME_NAME       | String of ASCII characters                          |

Note : Programmers are responsible to use these symbols properly.



## MEMORY MAP

*From ADAM™ Technical Reference Manual*

Note for ADAM users: The ADAM computer can be reset in either computer mode or in game mode. When the cartridge (or ColecoVision) reset switch is pressed, ADAM resets to game mode. In this mode, 32K of cartridge ROM are switched into the upper bank of memory, and OS 7' plus 24K of intrinsic RAM are switched into the lower bank of memory. So, it's possible to create a ColecoVision game with additional options if plugged into an ADAM computer and then use the extra RAM space and the ADAM peripherals.

## COLECOVISION GENERAL MEMORY MAP

*From ColecoVision FAQ*

| ADDRESS   | DESCRIPTION                        |
|-----------|------------------------------------|
| 0000-1FFF | ColecoVision BIOS OS 7'            |
| 2000-5FFF | Expansion port                     |
| 6000-7FFF | 1K RAM mapped into 8K. (7000-73FF) |
| 8000-FFFF | Game cartridge                     |

## GAME CARTRIDGE HEADER

*From The Absolute OS 7' Listing*

| ADDRESS   | NAME            | DESCRIPTION                                          |
|-----------|-----------------|------------------------------------------------------|
| 8000-8001 | CARTRIDGE       | Test bytes. Must be AA55 or 55AA.                    |
| 8002-8003 | LOCAL_SPR_TABLE | Pointer to RAM copy of the sprite name table.        |
| 8004-8005 | SPRITE_ORDER    | Pointer to RAM sprite order table.                   |
| 8006-8007 | WORK_BUFFER     | Pointer to free buffer space in RAM.                 |
| 8008-8009 | CONTROLLER_MAP  | Pointer to controller memory map.                    |
| 800A-800B | START_GAME      | Pointer to the start of the game.                    |
| 800C-800E | RST_8H_RAM      | Restart 8h soft vector.                              |
| 800F-8011 | RST_10H_RAM     | Restart 10h soft vector.                             |
| 8012-8014 | RST_18H_RAM     | Restart 18h soft vector.                             |
| 8015-8017 | RST_20H_RAM     | Restart 20h soft vector.                             |
| 8018-801A | RST_28H_RAM     | Restart 28h soft vector.                             |
| 801B-801D | RST_30H_RAM     | Restart 30h soft vector.                             |
| 801E-8020 | IRQ_INT_VECTOR  | Mask-able interrupt soft vector (38h).               |
| 8021-8023 | NMI_INT_VECTOR  | Non mask-able interrupt (NMI) soft vector.           |
| 8024-80XX | GAME_NAME       | String with two delimiters "/" as "LINE2/LINE1/YEAR" |

## COMPLET OS 7' RAM MAP

| ADDRESS   | NAME                 | DESCRIPTION                                                                               |
|-----------|----------------------|-------------------------------------------------------------------------------------------|
| 7020-7021 | PTR_LST_OF_SND_ADDRS | Pointer to list (in RAM) of sound addrs                                                   |
| 7022-7023 | PTR_TO_S_ON_0        | Pointer to song for noise                                                                 |
| 7024-7025 | PTR_TO_S_ON_1        | Pointer to song for channel#1                                                             |
| 7026-7027 | PTR_TO_S_ON_2        | Pointer to song for channel#2                                                             |
| 7028-7029 | PTR_TO_S_ON_3        | Pointer to song for channel#3                                                             |
| 702A      | SAVE_CTRL            | CTRL data (byte)                                                                          |
| 73B9      | STACK                | Beginning of the stack                                                                    |
| 73BA-73BF | PARAM_AREA           | Common passing parameters area (PASCAL)                                                   |
| 73C0-73C1 | TIMER_LENGTH         | Length of timer                                                                           |
| 73C2      | TEST_SIG_NUM         | Signal Code                                                                               |
| 73C3-73C4 | VDP_MODE_WORD        | Copy of data in the 1 <sup>st</sup> 2 VDP registers                                       |
| 73C5      | VDP_STATUS_BYTE      | Contents of default NMI handler                                                           |
| 73C6      | DEFER_WRITES         | Deferred sprites flag                                                                     |
| 73C7      | MUX_SPRITES          | Multiplexing sprites flag                                                                 |
| 73C8-73C9 | RAND_NUM             | Pseudo random number value                                                                |
| 73CA      | QUEUE_SIZE           | Size of the deferred write queue                                                          |
| 73CB      | QUEUE_HEAD           | Indice of the head of the write queue                                                     |
| 73CC      | QUEUE_TAIL           | Indice of the tail of the write queue                                                     |
| 73CD-73CE | HEAD_ADDRESS         | Address of the queue head                                                                 |
| 73CF-73D0 | TAIL_ADDRESS         | Address of the queue tail                                                                 |
| 73D1-73D2 | BUFFER               | Buffer pointer to deferred objects                                                        |
| 73D3-73D4 | TIMER_TABLE_BASE     | Timer base address                                                                        |
| 73D5-73D6 | NEXT_TIMER_DATA_BYTE | Next available timer address                                                              |
| 73D7-73EA | DBNCE_BUFF           | Debounce buffer. 5 pairs (old and state) of fire, joy, spin, arm and kbd for each player. |
| 73EB      | SPIN_SW0_CT          | Spinner counter port#1                                                                    |
| 73EC      | SPIN_SW1_CT          | Spinner counter port#2                                                                    |
| 73ED      | -                    | (reserved)                                                                                |
| 73EE      | S0_C0                | Segment 0 data, Controller port #1                                                        |
| 73EF      | S0_C1                | Segment 0 data, Controller port #2                                                        |
| 73F0      | S1_C0                | Segment 1 data, Controller port #1                                                        |
| 73F1      | S1_C1                | Segment 1 data, Controller port #2                                                        |
| 73F2-73FB | VRAM_ADDR_TABLE      | Block of VRAM table pointers                                                              |
| 73F2-73F3 | SPRITENAMETBL        | Sprite name table offset                                                                  |
| 73F4-73F5 | SPRITEGENTBL         | Sprite generator table offset                                                             |
| 73F6-73F7 | PATTERNNAMETBL       | Pattern name table offset                                                                 |
| 73F8-73F9 | PATTERNGENTBL        | Pattern generator table offset                                                            |
| 73FA-73FB | COLORTABLE           | Color table offset                                                                        |
| 73FC-73FD | SAVE_TEMP            | (no more used - in VRAM routines)                                                         |
| 73FE-73FF | SAVED_COUNT          | Copy of COUNT for PUT_VRAM & GET_VRAM                                                     |

## OS 7' AND EOS SIMILARITIES

Based on *The Hackers' Guide to ADAM™* and *The Absolute OS 7' Listing*

List of OS 7' symbols (calls & variables) similar to the EOS ones. For ColecoVision/ADAM programmers.

| EOS       | OS 7'       | SYMBOL                     |
|-----------|-------------|----------------------------|
| FD1A      | 1FDF        | WRITE_VRAM                 |
| FD1D      | 1FE2        | READ_VRAM                  |
| FD20      | 1FD9        | WRITE_REGISTER             |
| FD23      | 1FDC        | READ_REGISTER              |
| FD26      | 1F82        | FILL_VRAM                  |
| FD29      | 1FB8        | INIT_TABLE                 |
| FD2C      | 1FBE        | PUT_VRAM                   |
| FD2F      | 1FBB        | GET_VRAM                   |
| FD32      | 08C0        | CALC_OFFSET                |
| FD35      | 07E8        | PX_TO_PTRN_POS             |
| FD38      | 1F7F        | LOAD_ASCII                 |
| FD3B      | 1FC4        | WR_SPR_NM_TBL              |
| FD3E      | 1F76        | CONTROLLER_SCAN            |
| FD41      | 1F88        | UPDATE_SPINNER             |
| FD44      | 0190        | DECLSN                     |
| FD47      | 019B        | DECMSN                     |
| FD4A      | 01A6        | MSNTOLSN                   |
| FD4D      | 01B1        | ADD816                     |
| FD50      | 1FEE        | SOUND_INIT                 |
| FD53      | 1FD6        | TURN_OFF_SOUND             |
| FD56      | 1FF1        | PLAY_IT                    |
| FD59      | 1F61,1FF4   | PLAY_SONGS + SOUND_MAN     |
| FD5C      | 01D5? 02EE? | LEAVE_EFFECT? or EFXOVER?  |
| FD61-FD62 | 73C3-73C4   | VDP_MODE_WORD              |
| FD63      | 73C5        | STATUS_MODE_BYTE           |
| FD64-FD65 | 73F2-73F3   | SPRITENAMETBL              |
| FD66-FD67 | 73F4-73F5   | SPRITEGENTBL               |
| FD68-FD69 | 73F6-73F7   | PATTRNNAMETBL              |
| FD6A-FD6B | 73F8-73F9   | PATTRNGENTBL               |
| FD6C-FD6D | 73FA-73FB   | COLORTABLE                 |
| FE58      | 73EB        | SPIN_SW0_CT                |
| FE59      | 73EC        | SPIN_SW1_CT                |
| FE5A-FE65 | ????-????   | *CONTROLLER_MAP            |
| FE6E-FE6F | 7020-7021   | PTR_TO_LST_OF_SND_ADDRS    |
| FE70-FE71 | 7024-7025   | PTR_TO_S_ON_1 **NOT SURE** |
| FE72-FE73 | 7026-7027   | PTR_TO_S_ON_2 **NOT SURE** |
| FE74-FE75 | 7028-7029   | PTR_TO_S_ON_3 **NOT SURE** |
| FE76-FE77 | 7022-7023   | PTR_TO_S_ON_0 **NOT SURE** |
| FE78      | 702A        | SAVE_CTRL                  |

\* CONTROLLER\_MAP (in the cartridge header) points to the controller memory map used by the bios routine POLLER. The joystick data are decoded into 12 bytes : player#1 enable, player#2 enable, p1 fire, p1 joy, p1 spinner, p1 arm, p1 keypad, p2 fire, p2 joy, p2 spinner, p2 arm, p2 keypad.

## **Z80 I/O PORTS ASSIGNMENTS**

*Extracted from ADAM™ Technical Reference Manual*

Note: Ports # 000H through 07FH are reserved for the ADAM computer. They are mentioned here for those who want to elaborate special Coleco games with extra options when plugged in the ADAM.

### Video Display Processor

|               |      |
|---------------|------|
| Data port     | 0BEH |
| Register port | 0BFH |

### Sound Generator

|           |      |              |
|-----------|------|--------------|
| Data port | 0FFH | (write-only) |
|-----------|------|--------------|

### Game Controller

|                   |      |              |
|-------------------|------|--------------|
| Strobe Set port   | 080H | (write-only) |
| Strobe Reset port | 0C0H | (write-only) |
| Controller#1 port | 0FCH | (read-only)  |
| Controller#2 port | 0FFH | (read-only)  |

### MODEM

|              |      |
|--------------|------|
| Data port    | 05EH |
| Control port | 05FH |
| Auto Dialer  | 01EH |

### Expansion connector #2

|           |      |
|-----------|------|
| Data port | 04FH |
|-----------|------|

### Memory Map

|              |      |
|--------------|------|
| Control port | 07FH |
|--------------|------|

### Network reset

|  |      |                                            |
|--|------|--------------------------------------------|
|  | 03FH | (Performed by setting and resetting bit 0) |
|--|------|--------------------------------------------|

### EOS enable

|  |      |                              |
|--|------|------------------------------|
|  | 03FH | (Performed by setting bit 1) |
|--|------|------------------------------|

### EOS disable

|  |      |                                |
|--|------|--------------------------------|
|  | 03FH | (Performed by resetting bit 1) |
|--|------|--------------------------------|

# GAME CONTROLLERS

From ADAM™ Technical Reference Manual

The game controller contains an 8-position joystick, two push buttons (Fire and Arm) and a 12-key keypad. Remark: Extra push buttons (Fire 3 and Fire 4) were done after the Coleco bios for the SuperAction controllers, it's why they are not decoded by calling DECODER or POLLER. The information from a controller is read by the CPU on eight input lines through a single port. Once a port has been read, the input data must be decoded. See CONT\_SCAN (page 140) in OS 7' Listing for details.

## CONTROLLER CONFIGURATION

|                                                         | D <sub>6</sub> | D <sub>5</sub> | INT | D <sub>3</sub> | D <sub>2</sub> | D <sub>1</sub> | D <sub>0</sub> |                                           |   |   |   |
|---------------------------------------------------------|----------------|----------------|-----|----------------|----------------|----------------|----------------|-------------------------------------------|---|---|---|
| Fire                                                    | X              |                |     |                |                |                |                | Common 0<br>Enabled<br>By ports<br>FD, FF |   |   |   |
| North                                                   |                |                |     | X              |                |                |                |                                           |   |   |   |
| N-E                                                     |                |                |     | X              | X              |                |                |                                           |   |   |   |
| East                                                    |                |                |     |                | X              |                |                |                                           |   |   |   |
| S-E                                                     |                |                |     |                | X              | X              |                |                                           |   |   |   |
| South                                                   |                |                |     |                |                | X              |                |                                           |   |   |   |
| S-W                                                     |                |                |     |                |                | X              | X              |                                           |   |   |   |
| West                                                    |                |                |     |                |                |                | X              |                                           |   |   |   |
| N-W                                                     |                |                |     | X              |                |                | X              |                                           |   |   |   |
| Arm (Fire 2)                                            | X              |                |     |                |                |                |                | Common 1<br>Enabled<br>By ports<br>FC, FE |   |   |   |
| 2                                                       |                |                |     | X              |                |                |                |                                           |   |   |   |
| 3                                                       |                |                |     |                |                | X              | X              |                                           | 1 | 2 | 3 |
| 6                                                       |                |                |     |                |                |                | X              |                                           |   |   |   |
| 9                                                       |                |                |     |                | X              |                |                |                                           |   |   |   |
| 8                                                       |                |                |     | X              | X              | X              |                |                                           | 4 | 5 | 6 |
| 7                                                       |                |                |     | X              |                | X              |                |                                           |   |   |   |
| 4                                                       |                |                |     | X              | X              |                | X              |                                           | 7 | 8 | 9 |
| 1                                                       |                |                |     |                |                | X              |                |                                           |   |   |   |
| 5                                                       |                |                |     | X              | X              |                |                |                                           |   |   |   |
| 0                                                       |                |                |     |                | X              |                | X              |                                           | * | 0 | # |
| *                                                       |                |                |     |                | X              | X              |                |                                           |   |   |   |
| #                                                       |                |                |     | X              |                |                | X              |                                           |   |   |   |
| Fire 3                                                  |                |                |     |                | X              | X              | X              |                                           |   |   |   |
| Fire 4                                                  |                |                |     | X              |                | X              | X              |                                           |   |   |   |
| Spinner A                                               |                |                | X   |                |                |                |                | Always<br>Function                        |   |   |   |
| Spinner B<br>(presently<br>used in<br>Expansion Mod #2) |                | X              |     |                |                |                |                |                                           |   |   |   |

Remark : D<sub>4</sub> is named INT in the ColecoVision official documentations, including the absolute OS 7' bios listing.

Note : When a spinner is spinning, INT bit (Spinner A) is reset and D<sub>5</sub> bit (Spinner B) is set or reset depending on the way the spinner is spinning.

## SOUND GENERATOR

*From Daniel Bienvenu's CV programming documentation.  
For more technical information, read Texas Instrument SN76489AN.*

The ColecoVision uses the Texas Instruments SN76489A sound generator chip as the output port 0ffh. It contains three programmable tone generators, each with its own programmable attenuator, and a noise source with its own attenuator.

## TONE GENERATORS

Each tone generator consists of a frequency synthesis section requiring 10 bits of information to define half the period of the desired frequency. The frequency can be calculated with the following formula:

$$\text{frequency} = 3.579\text{MHz} / 32n, \text{ where } n \text{ is the 10-bit value.}$$

## NOISE GENERATOR

The noise generator consists of a noise source that is a shift register with an exclusive OR feedback network.

Noise Feedback Control:

| Feedback (FB) | Configuration         |
|---------------|-----------------------|
| 0             | Periodic Noise "buzz" |
| 1             | White Noise "shhh"    |

Noise Generator Frequency Control:

| NF1 | NF0 | Shift Rate          |
|-----|-----|---------------------|
| 0   | 0   | N/512               |
| 0   | 1   | N/1024              |
| 1   | 0   | N/2048              |
| 1   | 1   | Tone gen. #3 output |

## CONTROL REGISTERS

The SN76489A has 8 internal registers which are used to control the 3 tone generators and the noise source. During all data transfers to the SN76489A, the first byte contains a 3 bits field which determines the channel and the control/attenuation. The channel codes are shown below:

| R1 | R0 | Destination Control Register |
|----|----|------------------------------|
| 0  | 0  | Tone 1                       |
| 0  | 1  | Tone 2                       |
| 1  | 0  | Tone 3                       |
| 1  | 1  | Noise                        |

The output of the frequency flip-flop feeds into a 4 stage attenuator. The attenuator values, along with their bit position in the data word, are shown below. Multiple attenuation control bits may be true simultaneously. Thus, the maximum attenuation is 28 db.

| A3 | A2 | A1 | A0 | Weight |
|----|----|----|----|--------|
| 0  | 0  | 0  | 1  | 2 db   |
| 0  | 0  | 1  | 0  | 4 db   |
| 0  | 1  | 0  | 0  | 8 db   |
| 1  | 0  | 0  | 0  | 16 db  |
| 1  | 1  | 1  | 1  | OFF    |

Remark: Louder is the note, lower is the attenuation value.

## SOUND CONTROL DATA FORMATS

This is the data formats to be send directly to the sound port 0ffh.

### Frequency

| 1 | Reg. Addr |    |   | Data |    |    |    |
|---|-----------|----|---|------|----|----|----|
|   | R1        | R0 | 0 | F3   | F2 | F1 | F0 |

| 0 | X | Data |    |    |    |    |    |
|---|---|------|----|----|----|----|----|
|   |   | F9   | F8 | F7 | F6 | F5 | F4 |

### Noise Control

| 1 | Reg. Addr |   |   | X | FB | Shift |     |
|---|-----------|---|---|---|----|-------|-----|
|   | 1         | 1 | 0 |   |    | NF1   | NF0 |

### Attenuator

| 1 | Reg. Addr |    |   | Data |    |    |    |
|---|-----------|----|---|------|----|----|----|
|   | R1        | R0 | 1 | A3   | A2 | A1 | A0 |

## SOUND CONTROL NUMBERS TABLE

|         | Pitch                                                                  |                                                | Volume     |
|---------|------------------------------------------------------------------------|------------------------------------------------|------------|
|         | First byte                                                             | Second byte                                    | High - Off |
| Voice 1 | 80 - 8F                                                                | 00 - 3F                                        | 90 - 9F    |
| Voice 2 | A0 - AF                                                                | 00 - 3F                                        | B0 - BF    |
| Voice 3 | CO - CF                                                                | 00 - 3F                                        | D0 - DF    |
| Noise   | E0 - E3 (E3 = Voice 3)<br>E4 - E7 (E7 = Voice 3)<br>F0 - FF (FF = Off) | Periodic "buzz"<br>White "shhh"<br>Attenuation |            |

## SOUND DATA FORMAT

*From the Hackers' Guide to ADAM™*

The following information is the sound data format to be used in the songs encoded in coleco games.  
Channel # (2-bit values): 00 = Noise, 01 = Tone 1 Generator, 10 = Tone 2 Generator, 11 = Tone 3 Generator. A noisy sound needs a specific sound data format. Numbers 7 to 0 indicate bits position.

### REST

(no sound)

|           |   |        |   |   |   |   |   |
|-----------|---|--------|---|---|---|---|---|
| 7         | 6 | 5      | 4 | 3 | 2 | 1 | 0 |
| Channel # | 1 | Length |   |   |   |   |   |

### SIMPLE NOTE

|                          |   |   |   |   |   |                       |   |
|--------------------------|---|---|---|---|---|-----------------------|---|
| 7                        | 6 | 5 | 4 | 3 | 2 | 1                     | 0 |
| Channel #                | 0 | 0 | 0 | 0 | 0 | 0                     | 0 |
| Frequency (8 lower bits) |   |   |   |   |   |                       |   |
| Volume in 4 bits         |   |   |   | 0 | 0 | Frequency (2 hi-bits) |   |
| Length                   |   |   |   |   |   |                       |   |

### FREQUENCY SWEEP NOTE

|                          |   |   |   |                             |   |                       |   |
|--------------------------|---|---|---|-----------------------------|---|-----------------------|---|
| 7                        | 6 | 5 | 4 | 3                           | 2 | 1                     | 0 |
| Channel #                | 0 | 0 | 0 | 0                           | 0 | 0                     | 1 |
| Frequency (8 lower bits) |   |   |   |                             |   |                       |   |
| Volume in 4 bits         |   |   |   | 0                           | 0 | Frequency (2 hi-bits) |   |
| Number of steps in sweep |   |   |   |                             |   |                       |   |
| Step length              |   |   |   | 1 <sup>st</sup> step length |   |                       |   |
| Step size                |   |   |   |                             |   |                       |   |

### VOLUME SWEEP NOTE

|                          |   |   |   |                             |   |                       |   |
|--------------------------|---|---|---|-----------------------------|---|-----------------------|---|
| 7                        | 6 | 5 | 4 | 3                           | 2 | 1                     | 0 |
| Channel #                |   | 0 | 0 | 0                           | 0 | 1                     | 0 |
| Frequency (8 lower bits) |   |   |   |                             |   |                       |   |
| Volume in 4 bits         |   |   |   | 0                           | 0 | Frequency (2 hi-bits) |   |
| Length of note           |   |   |   |                             |   |                       |   |
| Step size                |   |   |   | Number of steps             |   |                       |   |
| Step length              |   |   |   | 1 <sup>st</sup> step length |   |                       |   |

### VOLUME AND FREQUENCY SWEEP NOTE

|                          |   |   |   |                                       |   |                       |   |
|--------------------------|---|---|---|---------------------------------------|---|-----------------------|---|
| 7                        | 6 | 5 | 4 | 3                                     | 2 | 1                     | 0 |
| Channel #                |   | 0 | 0 | 0                                     | 0 | 1                     | 1 |
| Frequency (8 lower bits) |   |   |   |                                       |   |                       |   |
| Volume in 4 bits         |   |   |   | 0                                     | 0 | Frequency (2 hi-bits) |   |
| Number of steps in sweep |   |   |   |                                       |   |                       |   |
| Frequency step length    |   |   |   | 1 <sup>st</sup> frequency step length |   |                       |   |
| Frequency step size      |   |   |   |                                       |   |                       |   |
| Volume step              |   |   |   | Number of volume step                 |   |                       |   |
| Volume step length       |   |   |   | 1 <sup>st</sup> volume step length    |   |                       |   |



## NOISE

|                  |   |   |   |   |    |     |     |
|------------------|---|---|---|---|----|-----|-----|
| 7                | 6 | 5 | 4 | 3 | 2  | 1   | 0   |
| 0                | 0 | 0 | 0 | 0 | 0  | 1   | 0   |
| Unused byte      |   |   |   |   |    |     |     |
| Volume in 4 bits |   |   |   | 0 | FB | NF1 | NF0 |
| Length of note   |   |   |   |   |    |     |     |

For the special meaning of FB, NF1 and NF0, read section SOUND GENERATOR (page 188).

## NOISE VOLUME SWEEP

|                |   |   |   |                                    |    |     |     |
|----------------|---|---|---|------------------------------------|----|-----|-----|
| 7              | 6 | 5 | 4 | 3                                  | 2  | 1   | 0   |
| 0              | 0 | 0 | 0 | 0                                  | 0  | 1   | 0   |
| Initial volume |   |   |   | 0                                  | FB | NF1 | NF0 |
| Length of note |   |   |   |                                    |    |     |     |
| Step size      |   |   |   | Number of volume step              |    |     |     |
| Step length    |   |   |   | 1 <sup>st</sup> volume step length |    |     |     |

For the special meaning of FB, NF1 and NF0, read section SOUND GENERATOR (page 188).

## SPECIAL EFFECT

|                                                                     |   |   |   |   |   |   |   |
|---------------------------------------------------------------------|---|---|---|---|---|---|---|
| 7                                                                   | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Channel #                                                           |   | 0 | 0 | 0 | 1 | 0 | 0 |
| Address of the special effect sub-routine<br>(in 2 bytes of course) |   |   |   |   |   |   |   |

## END OR REPEAT

|           |   |   |   |         |   |   |   |
|-----------|---|---|---|---------|---|---|---|
| 7         | 6 | 5 | 4 | 3       | 2 | 1 | 0 |
| Channel # |   | 0 | 1 | Repeat? | 0 | 0 | 0 |

## SOUND TABLES

Based on The Hackers' Guide to ADAM™ and The Absolute OS 7' Listing

### SONG DATA AREAS IN RAM

With SOUND\_INIT, the user initialize the song data areas in the cpu RAM. These song data areas are 10 bytes long and formatted like this:

|                                   |   |             |   |                                       |   |                       |   |
|-----------------------------------|---|-------------|---|---------------------------------------|---|-----------------------|---|
| 7                                 | 6 | 5           | 4 | 3                                     | 2 | 1                     | 0 |
| Channel #                         |   | Song number |   |                                       |   |                       |   |
| Address next note (8 lower bits)  |   |             |   |                                       |   |                       |   |
| Address next note (8 higher bits) |   |             |   |                                       |   |                       |   |
| Frequency (8 lower bits)          |   |             |   |                                       |   |                       |   |
| Volume in 4 bits                  |   |             |   | 0                                     | 0 | Frequency (2 hi-bits) |   |
| Length                            |   |             |   |                                       |   |                       |   |
| Frequency step length             |   |             |   | 1 <sup>st</sup> frequency step length |   |                       |   |
| Frequency step size               |   |             |   |                                       |   |                       |   |
| Volume step                       |   |             |   | Number of volume step                 |   |                       |   |
| Volume step length                |   |             |   | 1 <sup>st</sup> volume step length    |   |                       |   |

Right after the last song data area, a special END (00h) code indicates the end of the song data areas. It's the responsibility of the user to allocate enough free RAM space for the song data areas.

### SONG TABLE IN ROM

A song table consists of a number of entries. Each entry is composed into two addresses. The first address is a pointer to the song data in ROM encoded into the OS 7' sound data format. The second address is a pointer to the song data area in RAM. The first entry in the song table contains the address to the 1<sup>st</sup> song data area. More higher is the address of the song data area used by the song, more higher is the priority of this song.

### OUTPUT TABLE IN RAM

This table in RAM at 7020-702A contains pointers to the song table and to the active song data areas played through the sound channels. For the structure information of this table, see the section COMPLET OS 7' RAM MAP at page 184.

## NOTES AND FREQUENCIES

From Daniel Bienvenu's CV programming documentation.

### NOTE, FREQUENCY CONVERSION TABLE

|                                | Hz     | HEX | Hz     | HEX | Hz     | HEX | Hz     | HEX | Hz     | HEX |
|--------------------------------|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|
| A                              | 110.00 | 3F8 | 220.00 | 1FC | 440.00 | 0FE | 880.00 | 07F | 1760.0 | 03F |
| A <sup>#</sup> /B <sup>b</sup> | 116.54 | 3BF | 233.08 | 1DF | 466.16 | 0EF | 932.33 | 077 | 1864.6 | 03B |
| B                              | 123.47 | 389 | 246.94 | 1C4 | 493.88 | 0E2 | 987.77 | 071 | 1975.5 | 038 |
| C                              | 130.81 | 356 | 261.63 | 1AB | 523.25 | 0D5 | 1046.5 | 06A | 2093.0 | 035 |
| C <sup>#</sup> /D <sup>b</sup> | 138.59 | 327 | 277.18 | 193 | 554.36 | 0C9 | 1108.7 | 064 | 2217.5 | 032 |
| D                              | 146.83 | 2F9 | 293.66 | 17C | 587.33 | 0BE | 1174.7 | 05F | 2349.3 | 02F |
| D <sup>#</sup> /E <sup>b</sup> | 155.56 | 2CE | 311.13 | 167 | 622.25 | 0B3 | 1244.5 | 059 | 2489.0 | 02C |
| E                              | 164.81 | 2A6 | 329.63 | 153 | 659.25 | 0A9 | 1318.5 | 054 | 2637.0 | 02A |
| F                              | 174.61 | 280 | 349.23 | 140 | 698.46 | 0A0 | 1396.9 | 050 | 2793.8 | 028 |
| F <sup>#</sup> /G <sup>b</sup> | 185.00 | 25C | 370.00 | 12E | 739.99 | 097 | 1480.0 | 04B | 2960.0 | 025 |
| G                              | 196.00 | 23A | 391.99 | 11D | 783.99 | 08E | 1568.0 | 047 | 3136.0 | 023 |
| G <sup>#</sup> /A <sup>b</sup> | 207.65 | 21A | 415.30 | 10D | 830.61 | 086 | 1661.2 | 043 | 3322.4 | 021 |

Remark: Higher is the frequency, lower is its hex corresponding value.

## SCALES

A Scale is a series of notes which we define as "correct" or appropriate for a song.

Examples of various Scales (Root = "C"):

| Name                 | C | D <sup>b</sup> | D | E <sup>b</sup> | E | F | G <sup>b</sup> | G | A <sup>b</sup> | A | B <sup>b</sup> | B |
|----------------------|---|----------------|---|----------------|---|---|----------------|---|----------------|---|----------------|---|
| Major                | 1 |                | 2 |                | 3 | 4 |                | 5 |                | 6 |                | 7 |
| Major Triad          | 1 |                |   |                | 2 |   |                | 3 |                |   |                |   |
| Minor                | 1 |                | 2 | 3              |   | 4 |                | 5 | 6              |   | 7              |   |
| Minor Triad          | 1 |                |   | 2              |   |   |                | 3 |                |   |                |   |
| Harmonic Minor       | 1 |                | 2 | 3              |   | 4 |                | 5 | 6              |   |                | 7 |
| Melodic Minor (asc)  | 1 |                | 2 | 3              |   | 4 |                | 5 |                | 6 |                | 7 |
| Melodic Minor (desc) | 1 |                | 2 | 3              |   | 4 |                | 5 | 6              |   | 7              |   |
| Enigmatic            | 1 | 2              |   |                | 3 |   | 4              |   | 5              |   | 6              | 7 |
| Flamenco             | 1 | 2              |   | 3              | 4 | 5 |                | 6 | 7              |   | 8              |   |

## VDP - VIDEO DISPLAY PROCESSOR

From Texas Instrument documentation

VDP has 8 control registers (0-7) and 1 status register.

### VDP REGISTERS

| Control registers | Register Bits |      |      |      |      |      |      |      |
|-------------------|---------------|------|------|------|------|------|------|------|
|                   | 7             | 6    | 5    | 4    | 3    | 2    | 1    | 0    |
| 0                 | -             | -    | -    | -    | -    | -    | M2   | EXT  |
| 1                 | 4/16K         | BL   | GINT | M1   | M3   | -    | SI   | MAG  |
| 2                 | -             | -    | -    | -    | PN13 | PN12 | PN11 | PN10 |
| 3                 | CT13          | CT12 | CT11 | CT10 | CT9  | CT8  | CT7  | CT6  |
| 4                 | -             | -    | -    | -    | -    | PG13 | PG12 | PG11 |
| 5                 | -             | SA13 | SA12 | SA11 | SA10 | SA9  | SA8  | SA7  |
| 6                 | -             | -    | -    | -    | -    | SG13 | SG12 | SG11 |
| 7                 | TC3           | TC2  | TC1  | TC0  | BD3  | BD2  | BD1  | BD0  |

|            |                                                                           |
|------------|---------------------------------------------------------------------------|
| M1, M2, M3 | Select screen mode                                                        |
| EXT        | Enables external video input                                              |
| 4/16K      | Selects 16K Video RAM if set                                              |
| BL         | Blank screen if reset                                                     |
| SI         | 16x16 sprites if set; 8x8 if not                                          |
| MAG        | Sprites enlarged if set (double sized: sprite pixels are 2x2)             |
| GINT       | Generate interrupts if set                                                |
| PN         | Address for pattern name table (screen) = $R2 * 400h$                     |
| CT         | Address for colour table (special meaning in M2) = $R3 * 40h$             |
| PG         | Address for pattern generator table (special meaning in M2) = $R4 * 800h$ |
| SA         | Address for sprite attribute (y, x, pattern, colour) table = $R5 * 80h$   |
| SG         | Address for sprite generator table = $R6 * 800h$                          |
| TC         | Text colour (foreground)                                                  |
| BD         | Backdrop (background + border)                                            |

### STATUS REGISTER

| INT | 5S | C | FS4 | FS3 | FS2 | FS1 | FS0 |
|-----|----|---|-----|-----|-----|-----|-----|
|-----|----|---|-----|-----|-----|-----|-----|

|     |                                                               |
|-----|---------------------------------------------------------------|
| FS  | Fifth sprite (first sprite not displayed). Valid if 5S is set |
| C   | Sprite collision detected                                     |
| 5S  | Fifth sprite (not displayed) detected                         |
| INT | Set at each screen update (refresh)                           |

## VDP REGISTER ACCESS

The status register can't be write. After reading the status register, INT (bit#7) and C (bit#5) are reset.

ASM:    in       a,(0bfh) ; get register value

COLECO BIOS : 1FDC   ; Output A = vdp status register value.

The control registers can't be read. Two bytes must be written:

|        | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|
| Byte 0 | V7    | V6    | V5    | V4    | V3    | V2    | V1    | V0    |
| Byte 1 | 1     | -     | -     | -     | -     | R2    | R1    | R0    |

### Legend

V\*       Value to be written in the register. (V7-V0)

R\*       Register number. (R2-R0)

```
ASM:  ld      a, value
      out     (0bfh),a ; set value
      ld      a, register_number
      add     a,80h
      out     (0bfh),a ; write value in register
```

COLECO BIOS : 1FD9   ; Input C = data, B = register #.

## VDP MEMORY ACCESS

To read or write video memory data, two bytes must be written to set the video memory offset address.

|        | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|
| Byte 0 | A7    | A6    | A5    | A4    | A3    | A2    | A1    | A0    |
| Byte 1 | 0     | R/W   | A13   | A12   | A11   | A10   | A9    | A8    |

### Legend

A\*       Memory address. (A13-A0)

R/W      Flag is set to write, reset to read.

; HL = Video Memory Offset.

```
ASM:  ld      a,l
      out     (0bfh),a ; low-addr.
      ld      a, h
      add     a,40h   ; write flag
      out     (0bfh),a ; hi-addr.
```

After setting the video memory address, simply read or write data through the video data port (0beh). The offset address in video memory is auto-incremented after each 1-byte transfer.

COLECO BIOS : 1FDF   ; Write VRAM : DE = offset, HL = pointer to data buffer, BC = count

COLECO BIOS : 1FE2   ; Read VRAM : DE = offset, HL = pointer to data buffer, BC = count

## VRAM MEMORY ACCESS DELAY TIMES

The amount of time necessary for the CPU to transfer a byte of data to or from VRAM memory can vary from 2 to 7.95 microseconds. Once the VDP has been told to read or write a byte of data to or from VRAM it takes approximately 2 microseconds until the VDP is ready to make the data transfer. In addition to this delay, the VDP must wait for a CPU access window; i.e., the period of time when the VDP is not occupied with the memory refresh or screen display and is available to read or write data. Summary of these delay times in microseconds are showed in the following table.

| Screen Mode              | Condition                                               | VDP Delay | Time waiting for an access window | Total Time |
|--------------------------|---------------------------------------------------------|-----------|-----------------------------------|------------|
| Graphics I, II<br>M0, M2 | Active Display Area                                     | 2         | 0 - 5.95*                         | 2 - 7.95*  |
| Text<br>M1               | Active Display Area                                     | 2         | 0 - 1.1                           | 2 - 3.1    |
| Multicolor<br>M3         | Active Display Area                                     | 2         | 0 - 1.5                           | 2 - 3.5    |
| All                      | Screen is Blanked                                       | 2         | 0                                 | 2          |
| All                      | 4300 microseconds<br>after Vertical<br>Interrupt Signal | 2         | 0                                 | 2          |

\*: The worst case time between windows occurs during the Graphics I or II screen mode when sprites are being used.

Two situations occur where the time waiting for an access window is effectively zero:

1. Screen is blanked by resetting the blank bit of register 0.
2. VDP is in the vertical refresh mode. This mode came right after the active display area period. An interrupt output signal (NMI) indicates that the VDP is entering the vertical refresh mode and that for the next 4300 microseconds. The program that monitors the interrupt output must allow for its own delays in responding to the interrupt signal (NMI) and recognize how much time it has left during the refresh period. The CPU must set the interrupt enable bit (GINT) of Register 1 in order to enable the interrupt for each frame, and then read the status register each time an interrupt is issued to clear the interrupt output. See NMI section for details.

## NMI - Non Maskable Interrupt

The VDP output pin is used to generate an interrupt at the end of each active-display scan which is about every 1/60 second for the TMS9928A (NTSC) and 1/50 second for the TMS9929A (PAL). The interrupt output signal is active when the generate interrupts bit (GINT) in VDP Register 1 is set and the bit 7 (INT) of the status register is set. Interrupts are cleared when status register is read.

In other words:

- After a vertical retrace (refresh done), the bit 7 of the status register is set.
- If GINT (bit 5 of control register#1) is set, the NMI interrupts the normal execution.
- When it's time again to refresh, the bit 7 of the status register is reset.

NMI can be used to execute something again and again at a regular speed like updating graphics, sounds or calling the game engine (game loop).

## COLOR PALETTE

| COLOR # | COLOR                              | Y    | R-Y  | B-Y  |
|---------|------------------------------------|------|------|------|
| 0       | Invisible                          | -    | -    | -    |
| 1       | Black                              | 0.00 | 0.47 | 0.47 |
| 2       | Medium Green                       | 0.53 | 0.07 | 0.20 |
| 3       | Light Green                        | 0.67 | 0.17 | 0.27 |
| 4       | Dark blue                          | 0.40 | 0.40 | 1.00 |
| 5       | Light blue                         | 0.53 | 0.43 | 0.93 |
| 6       | Dark Red (brown)                   | 0.47 | 0.83 | 0.30 |
| 7       | Cyan                               | 0.73 | 0.00 | 0.70 |
| 8       | Medium Red                         | 0.53 | 0.93 | 0.27 |
| 9       | Light Red (Pink/orange)            | 0.67 | 0.93 | 0.27 |
| 10 (A)  | Dark Yellow (Yellow)               | 0.73 | 0.57 | 0.07 |
| 11 (B)  | Light Yellow (Yellow + Light Grey) | 0.80 | 0.57 | 0.17 |
| 12 (C)  | Dark Green                         | 0.47 | 0.13 | 0.23 |
| 13 (D)  | Magenta                            | 0.53 | 0.73 | 0.67 |
| 14 (E)  | Grey (Light Grey)                  | 0.80 | 0.47 | 0.47 |
| 15 (F)  | White                              | 1.00 | 0.47 | 0.47 |

TMS9928 color palette calculated by Richard F. Drushel, based on the TMS9928 technical documentation.



TMS9938 color palette calculated by Marat Fayzullin



TMS9928 color palette used in MESS emulator



The default color palette used in ADAMEM is the one based on the TMS9928 technical documentation.

The color palette used in COLEM is the one calculated by Marat Fayzullin.

The color palette I see in my Commodore monitor model 1802 looks like the one used in MESS emulator.

More information about Texas Instruments TMS99n8 color palette.

URL:

<http://junior.apk.net/~drushel/pub/coleco/twwmca/wk961118.html>

<http://junior.apk.net/~drushel/pub/coleco/twwmca/wk961201.html>

<http://junior.apk.net/~drushel/pub/coleco/twwmca/wk970202.html>

## VIDEO DISPLAY SUMMARY

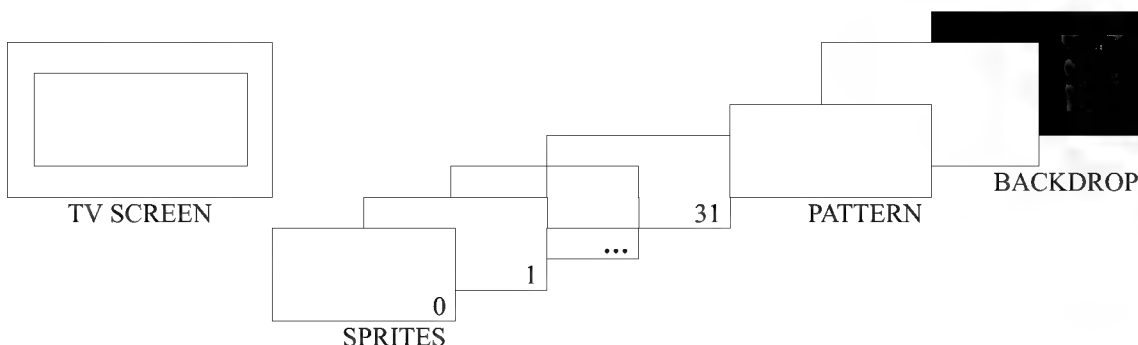
*Based on The Hackers' Guide to ADAM™ and Texas Instrument documentation*

The VDP displays an image on the screen that can be envisioned as a set of display planes sandwiched together. The objects on planes closest to the viewer have higher priority. In cases where two or more entities on different planes are occupying the same spot on screen, the entity on the higher priority plane will show at that point.

The first 32 planes each may contain a single sprite. Since the coordinates of the sprite are in terms of pixels, the sprite can be positioned and moved about very accurately. Sprites are available in three sizes: 8x8 pixels, 16x16 pixels, and 32x32 pixels. The sprites are showed in Multicolor and Graphics modes only. There is also a restriction on the number of sprites on a line: only 4 sprites can be active on any horizontal line, the additional sprites will be automatically made transparent.

Behind the sprite planes is the pattern plane. The pattern plane is used for textual and graphics images generated by the different screen modes. The pattern plane is broken into group of pixels called pattern positions. Since the full image is 256x192 pixels, there are 32x24 pattern positions (of 8x8 pixels) on the screen in the Graphics modes, 40x24 positions (of 6x8 pixels) on the screen in the Text mode, and 64x48 positions (of 4x4 pixels) on the screen in the Multicolor mode.

Behind the pattern plane is the backdrop, which is larger in area than the other planes so that it forms a border around the other planes. The backdrop consists of a single color used for the display borders and as the default color for the active display area. The default color is stored in the VDP register 7. When the backdrop color is transparent, the backdrop automatically defaults to black.





## VDP Screen modes

### Mode 0 - Graphics I

Description: 32x24 characters, two colors per 8 characters, sprites active.

### Mode 1 - Text

Description: 40x24 characters (6x8), colors set in control register#7, sprites inactive.

### Mode 2 - Graphics II

Description: 32x24 characters, 256x192 pixels, two colors per line of 8 pixels, sprites active.

Special meaning for CT\* and PG\*:

At control register#3, only bit 7 (CT13) sets the address of the color table (address: 0000 or 2000). Bits 6 - 0 are an AND mask over the top 7 bits of the character number.

At control register#4, only bit 2 (PG13) sets the address of the pattern table (address: 0000 or 2000). Bits 1 and 0 are an AND mask over the top 2 bits of the character number. If the AND mask is:

- 00, only one set (the first one) of 256 characters is used on screen.
- 01, the middle of the screen (8 rows) use another set (the second one) of 256 characters.
- 10, the bottom of the screen (8 rows) use another set (the third one) of 256 characters.
- 11, three set of 256 characters are used on screen: set one at the top 8 rows, set two in the middle 8 rows, and set three at the bottom 8 rows. This particular mode is normally used as a bitmap mode screen. The bitmap mode screen is in fact all three characters sets (top, middle and bottom) showed on screen at the same time by filling the screen with all the characters.

### Mode 3 - Multicolor

Description: 64x48 big pixels (4x4), sprites active.

## SPRITES

*From Daniel Bienvenu's CV programming documentation.*

The sprites are easy to use because you can place them anywhere on screen. Each sprite can be identified like a layer on screen. Normally, the size of a sprite is 16x16 but there is also the 8x8 format. The limits for using sprites are : never more than 4 sprites in a row, on the same scan line and never more than 32 sprites on screen at the same time. All sprites can be magnified by 2 (by changing size of the pixels in sprites).

To display a sprite on screen, you need a vector of 4 bytes (Position Y, Position X, Pattern and Colour) in the right video memory location.

## SPRITES COLOR

The bits 0 are already replaced by the transparent color so there is only one color per sprite.

To use more than one color, you have two solutions:

- Use more than one sprite (one for each color)
- Use a combination of sprites and characters.

## SPRITES LOCATIONS ON SCREEN

The Y location of a sprite can be any values between 0 and 255 except 208. The special value 208 tells the video chip to stop checking for sprites to display on screen. If you want to not show sprite#1 but you want to show sprite#2, use a value like 207 for the Y location of sprite#1.

## SPRITES PATTERN

### 8x8 SPRITE

A 8x8 sprite looks like a character in screen mode 0 but all bits 0 are colored with the invisible color 0.

### 16x16 SPRITE

A 16x16 sprite is a combination of four (4) 8x8 patterns. These patterns are displayed like this:

|   |   |
|---|---|
| 1 | 3 |
| 2 | 4 |

## SPRITE 8x8 SAMPLE

| Spaceship Pattern |   |   |   |   |   |   |   | Pattern Codes |  | Spaceship Color |      |
|-------------------|---|---|---|---|---|---|---|---------------|--|-----------------|------|
| 0                 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 18            |  | Color           | Code |
| 1                 | 0 | 0 |   |   | 0 | 0 | 1 | 99            |  |                 | 4    |
|                   | 0 | 0 |   |   | 0 | 0 |   | 99            |  |                 |      |
|                   | 0 | 1 | 1 | 1 |   | 0 | 1 | BD            |  |                 |      |
|                   | 1 |   | 0 | 0 |   | 1 | 1 | E7            |  |                 |      |
|                   | 1 |   | 0 | 0 |   | 1 | 1 | E7            |  |                 |      |
| 1                 | 0 | 1 | 1 | 1 |   | 0 | 1 | BD            |  |                 |      |
| 0                 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 3C            |  |                 |      |

## SPRITE 16x16 SAMPLE

| Face Pattern |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | Pattern Codes |    | Face Color |      |
|--------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---------------|----|------------|------|
| 0            | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00            | 00 | Color      | Code |
| 0            | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 03            | E0 |            | A    |
| 0            | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0F            | F8 |            |      |
| 0            | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 19            | CC |            |      |
| 0            | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 36            | B6 |            |      |
| 0            | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 3F            | FE |            |      |
| 0            | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7F            | FF |            |      |
| 0            | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7F            | FF |            |      |
| 0            | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7F            | FF |            |      |
| 0            | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 70            | 07 |            |      |
| 0            | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 30            | 06 |            |      |
| 0            | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 38            | 0E |            |      |
| 0            | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1E            | 3C |            |      |
| 0            | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0F            | F8 |            |      |
| 0            | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 03            | E0 |            |      |
| 0            | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00            | 00 |            |      |

This sprite pattern is coded like this in the video memory (VRAM) :

00, 03, 0F, 19, 36, 3F, 7F, 7F, 7F, 70, 30, 38, 1E, 0F, 03, 00, 00, E0, F8, CC, B6, FE, FF, FF, FF, FF, 07, 06, 0E, 3C, F8, E0, 00.

# CHARACTERS

*From Daniel Bienvenu's CV programming documentation.*

The characters, also named names in the official coleco documents, are normally used as a background or semi-mobile objects. All the letters, numbers and symbols are characters. A character is 8x8 pixels sized except for screen mode 1 where a character is only 6x8. The characters can be copied many times on screen but only at specific positions. Normally, there are 768 spaces (32 columns x 24 rows) on screen where characters can be placed except for screen mode 1 (40 columns x 24 rows).

## VIDEO MEMORY FOR CHARACTERS

The names of the three tables in Video RAM for characters are:

NAME: The screen. It contains characters # for all the spaces on screen.

PATTERN: The characters pattern (256 characters # : HEX values from 00 to FF)

COLOR: The characters color(s)

A character has the same pattern and color anywhere on screen (one exception with screen mode 2). So you can't use the same character to print a blue 'A' and a red 'A' side-by-side. The solution is using two characters with the same pattern 'A' but with different colors, one blue, one red.

You must understand the difference between the ASCII code and the symbol. In the ASCII code, the character '1' is not the character # 1 but the character # 49. But, by changing the patterns, you can make the character #1 looks like a '1' on screen if you like.

Now, if the color of the character (# 65, 41 in HEX value) 'A' is blue and if you change the pattern of the character (# 49, 31 in HEX value) '1' to looks like an 'A' but with a red color, then you just have to put the characters 'A' and '1' (values # 65 and # 49) side-by-side on screen to see two 'A's side-by-side but one blue and one red.

In the NAME table, there is HEX values 41 for the 'A' and 31 for the '1'.

In the PATTERN table, there are identical pattern data for the character 'A' and '1'.

In the COLOR table, there are different values to set a blue color for the character 'A' and a red color for the character '1' that looks now like an 'A'.

- Screen mode 0: there are only two colors (one color for bits 1 and one color for bits 0) for each bloc of 8 characters in the character set.
- Screen mode 1: there are only two colors (one color for bits 1 and one color for bits 0) for all the characters. These colors are set in VDP register 7.
- Screen mode 2: there are two colors (one color for bits 1 and one color for bits 0) per line of 8 pixels for all the characters in the character set.

For the screen mode 0 and 2, if you want to see the background color set in the VDP register, you have to use the transparent color code.

## CHARACTER PATTERN

Characters are named names in the official Coleco documents, and tiles by some programmers. A character on screen is defined by a number that represent a pattern in the PATTERN GENERATOR table in VRAM at a specific location in the NAME table in VRAM. A character pattern is a 8x8 pixels graphic, 6x8 for screen mode 1.

## CHARACTER PATTERN SAMPLE

### Screen Mode 0 Character Sample

A 8x8 character pattern sample that use only two colors (one for bits 1 and one for bits 0).

| Spaceship Pattern |   |   |   |   |   |   |   | Pattern Codes | Spaceship Colors |        |      |
|-------------------|---|---|---|---|---|---|---|---------------|------------------|--------|------|
|                   |   |   |   |   |   |   |   |               | Bits 1           | Bits 0 | Code |
| 0                 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 18            |                  |        | E1   |
| 1                 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 99            |                  |        |      |
| 1                 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 99            |                  |        |      |
| 1                 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | BD            |                  |        |      |
| 1                 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | E7            |                  |        |      |
| 1                 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | E7            |                  |        |      |
| 1                 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | BD            |                  |        |      |
| 0                 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 3C            |                  |        |      |

### Screen Mode 1 Character Sample

A 6x8 character pattern that use only the colors set in the vdp control register #7.

| Spaceship Pattern |   |   |   |   |   |   |   | Pattern Codes | Spaceship Colors |        |      |
|-------------------|---|---|---|---|---|---|---|---------------|------------------|--------|------|
|                   |   |   |   |   |   |   |   |               | Bits 1           | Bits 0 | Code |
| 0                 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 30            |                  |        | E1   |
| 1                 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | B4            |                  |        |      |
| 1                 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | B4            |                  |        |      |
| 1                 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | FC            |                  |        |      |
| 1                 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | CC            |                  |        |      |
| 1                 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | CC            |                  |        |      |
| 1                 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | FC            |                  |        |      |
| 0                 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 78            |                  |        |      |

### Screen Mode 2 Character Sample

A 8x8 character pattern that use two colors per line.

| Spaceship Pattern |   |   |   |   |   |   |   | Pattern Codes | Spaceship Colors |        |       |
|-------------------|---|---|---|---|---|---|---|---------------|------------------|--------|-------|
|                   |   |   |   |   |   |   |   |               | Bits 1           | Bits 0 | Codes |
| 0                 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 18            |                  |        | 81    |
| 1                 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 99            |                  |        | A1    |
| 1                 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 99            |                  |        | E1    |
| 1                 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | BD            |                  |        | E1    |
| 1                 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | E7            |                  |        | EF    |
| 1                 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | E7            |                  |        | E7    |
| 1                 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | BD            |                  |        | E1    |
| 0                 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 3C            |                  |        | 81    |

## COLECO ASCII TABLE

DEC: 0-63

HEX: 00-3F

| DEC | HEX | CHARACTER | DEC | HEX | CHARACTER |
|-----|-----|-----------|-----|-----|-----------|
| 0   | 00  |           | 32  | 20  | Space     |
| 1   | 01  |           | 33  | 21  | !         |
| 2   | 02  |           | 34  | 22  | "         |
| 3   | 03  |           | 35  | 23  | #         |
| 4   | 04  |           | 36  | 24  | \$        |
| 5   | 05  |           | 37  | 25  | %         |
| 6   | 06  |           | 38  | 26  | &         |
| 7   | 07  |           | 39  | 27  | '         |
| 8   | 08  |           | 40  | 28  | (         |
| 9   | 09  |           | 41  | 29  | )         |
| 10  | 0A  |           | 42  | 2A  | *         |
| 11  | 0B  |           | 43  | 2B  | +         |
| 12  | 0C  |           | 44  | 2C  | ,         |
| 13  | 0D  |           | 45  | 2D  | -         |
| 14  | 0E  |           | 46  | 2E  | .         |
| 15  | 0F  |           | 47  | 2F  | /         |
| 16  | 10  |           | 48  | 30  | 0         |
| 17  | 11  |           | 49  | 31  | 1         |
| 18  | 12  |           | 50  | 32  | 2         |
| 19  | 13  |           | 51  | 33  | 3         |
| 20  | 14  |           | 52  | 34  | 4         |
| 21  | 15  |           | 53  | 35  | 5         |
| 22  | 16  |           | 54  | 36  | 6         |
| 23  | 17  |           | 55  | 37  | 7         |
| 24  | 18  |           | 56  | 38  | 8         |
| 25  | 19  |           | 57  | 39  | 9         |
| 26  | 1A  |           | 58  | 3A  | :         |
| 27  | 1B  |           | 59  | 3B  | ;         |
| 28  | 1C  |           | 60  | 3C  | <         |
| 29  | 1D  | ©         | 61  | 3D  | =         |
| 30  | 1E  | T         | 62  | 3E  | >         |
| 31  | 1F  | M         | 63  | 3F  | ?         |

DEC: 64-127  
 HEX: 40-7F

| DEC | HEX | CHARACTER     | DEC | HEX | CHARACTER         |
|-----|-----|---------------|-----|-----|-------------------|
| 64  | 40  | @             | 96  | 60  | `                 |
| 65  | 41  | A             | 97  | 61  | a                 |
| 66  | 42  | B             | 98  | 62  | b                 |
| 67  | 43  | C             | 99  | 63  | c                 |
| 68  | 44  | D             | 100 | 64  | d                 |
| 69  | 45  | E             | 101 | 65  | e                 |
| 70  | 46  | F             | 102 | 66  | f                 |
| 71  | 47  | G             | 103 | 67  | g                 |
| 72  | 48  | H             | 104 | 68  | h                 |
| 73  | 49  | I             | 105 | 69  | i                 |
| 74  | 4A  | J             | 106 | 6A  | j                 |
| 75  | 4B  | K             | 107 | 6B  | k                 |
| 76  | 4C  | L             | 108 | 6C  | l                 |
| 77  | 4D  | M             | 109 | 6D  | m                 |
| 78  | 4E  | N             | 110 | 6E  | n                 |
| 79  | 4F  | O             | 111 | 6F  | o                 |
| 80  | 50  | P             | 112 | 70  | p                 |
| 81  | 51  | Q             | 113 | 71  | q                 |
| 82  | 52  | R             | 114 | 72  | r                 |
| 83  | 53  | S             | 115 | 73  | s                 |
| 84  | 54  | T             | 116 | 74  | t                 |
| 85  | 55  | U             | 117 | 75  | u                 |
| 86  | 56  | V             | 118 | 76  | v                 |
| 87  | 57  | W             | 119 | 77  | w                 |
| 88  | 58  | X             | 120 | 78  | x                 |
| 89  | 59  | Y             | 121 | 79  | y                 |
| 90  | 5A  | Z             | 122 | 7A  | z                 |
| 91  | 5B  | [             | 123 | 7B  | { (brace left)    |
| 92  | 5C  | \             | 124 | 7C  | (broken vertical) |
| 93  | 5D  | ]             | 125 | 7D  | } (brace right)   |
| 94  | 5E  | ^             | 126 | 7E  | ~ (tilde)         |
| 95  | 5F  | _ (underline) | 127 | 7F  | ␣                 |

## **GLOSSARY**

ATN: Attenuator

LSB: Less Significant Byte

LSN: Less Significant Nibble

MSB: Most Significant Byte

MSN: Most Significant Nibble

Nibble: 4-bit (half-byte)

Byte: 8-bit

Word: 16-bit